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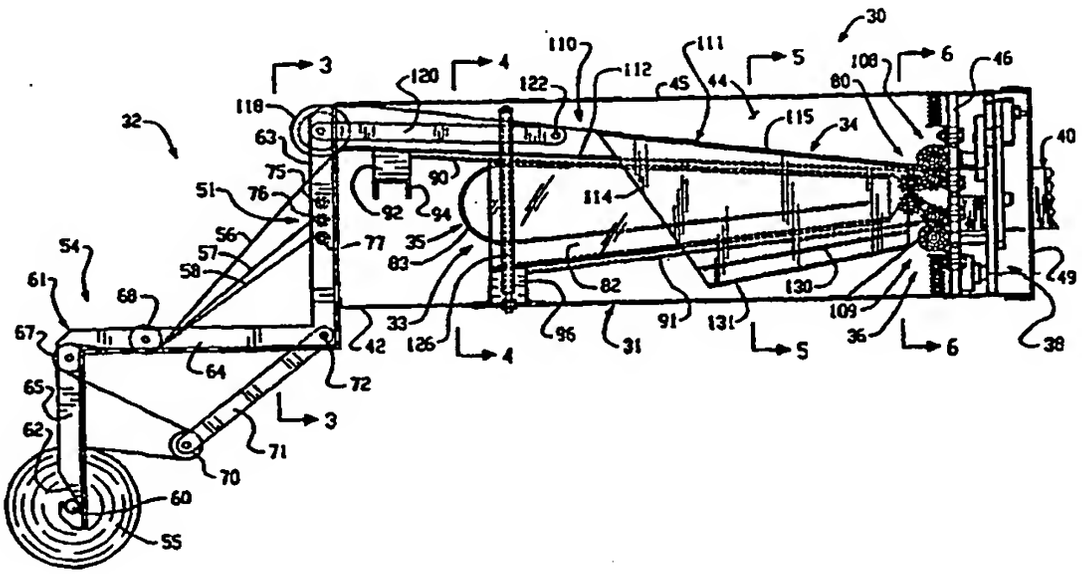

(57) Abstract

Cushioning conversion machines and methods are provided for converting plural layers (56, 57, 58) of a sheet-like stock material into a dunnage product. The plural layers (56, 57, 58) of the stock material are shaped into a three-dimensional strip of dunnage and the overlapped edge portions of a first layer (56) of the stock material are connected together separate from a central portion of the first layer (56). The overlapped edge portions of the first layer (56) may be generally coplanar with its adjacent unoverlapped portions. The overlapped edge portions of the first layer (56) may be connected together separate from other layers of the sheet-like stock material. Alternatively, the lateral edges of the other layers of the sheet-like stock material may be connected to each other and also the lateral edges of the first layer, but not to the respective central portions of the layers.

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MACHINE FOR CONVERTING STOCK MATERIAL INTO A CUSHIONING PRODUCT

The herein described invention relates generally to a cushioning conversion machine and method for converting sheet-like stock material into a cushioning product, and a resultant novel cushioning product.

In the process of shipping an item from one location to another, a protective packaging material is typically placed in the shipping case, or box, to fill any voids and/or to cushion the item during the shipping process. Some conventional protective packaging materials are plastic foam peanuts and plastic bubble pack. While these conventional plastic materials seem to adequately perform as cushioning products, they are not without disadvantages. Perhaps the most serious drawback of plastic bubble wrap and/or plastic foam peanuts is their effect on our environment. Quite simply, these plastic packaging materials are not biodegradable and thus they cannot avoid further multiplying our planet's already critical waste disposal problems. The non-biodegradability of these packaging materials has become increasingly important in light of many industries adopting more progressive policies in terms of environmental responsibility.

The foregoing and other disadvantages of conventional plastic packaging materials have made paper protective packaging material a very popular alterative. Paper is biodegradable, recyclable and renewable, making it an environmentally responsible choice for conscientious industries.

While paper in sheet form could possibly be used as a protective packaging material, it is usually preferable to convert the sheets of paper into a relatively low density pad-like cushioning dunnage product. This conversion may be accomplished by a cushioning conversion machine/method, such as those disclosed in U.S. Patent Nos. 3,509,798, 3,603,216, 3,655,500, 3,779,039, 4,026,198, 4,109,040, 4,717,613 and 4,750,896, and also in pending U.S. Patent Applications Nos. 07/533,755, 07/538,181, 07/592,572, 07/734,512, 07/786,573, 07/840,306 and 07/861,225.

With most, if not all, of the conversion machines/methods disclosed in the above-identified patents and applications, the cushioning product is created by converting multi-layer, and preferably three-layer, paper stock material into a desired geometry. The cushioning product includes pillow-like portions formed by the lateral edges of all of the layers of stock paper being rolled inwardly to form a pair of twin spirals. The central regions of this structure are then compressed and connected (such

as by coining) to form a central compressed portion and two lateral pillow-like portions which essentially account for the cushioning qualities of the product.

The central compressed portion of such a cushioning product is believed to be necessary to ensure that the pillow-like portions optimally maintain their cushioning qualities. In other words, without a connection of this type, the resiliency of the pillow-like portions would encourage the twin spirals to "unwind." However, the central portion, due to its compressed state, increases the density of the overall cushioning product.

In the past, attempts have been made to decrease the density of the cushioning products by altering its construction. Specifically, U.S. Patent No. 4,717,613 introduced a conversion process/machine which creates a lower density cushioning product. The decrease in density is accomplished by urging the stock material outwardly into the pillow-like portions whereby the central compressed section is comprised of a lesser amount of stock material.

Despite past improvements, a need remains for conversion machines/methods which create paper cushioning products of even lower densities. Moreover, irrespective of particular density properties, environmental and other concerns provide a constant desire for new and effective paper cushioning products and for machines/methods for creating such products.

The present invention provides a cushioning conversion machine and method for converting multiple layer of sheet-like stock material into a cushioning product. The construction of the cushioning product is such that the product's overall density is relatively low while at the same time the integrity of the product's cushioning qualities are maintained. Moreover, the cushioning product of the present invention may be, and preferably is, made of paper which is biodegradable, recyclable and renewable. Accordingly, the present invention provides an environmentally responsible alternative to plastic packaging products.

In accordance with broad aspects of the invention, cushioning conversion machines and methods are provided for converting plural layers of a sheet-like stock material into a dunnage product.

According to one broad aspect of the invention, a machine/method includes an assembly/step in which plural layers of the stock material are shaped into a three-dimensional strip of dunnage. In the strip of dunnage, at least a first layer of the stock material has overlapped edge portions which are generally coplanar with adjacent unoverlapped portions of the first layer. The machine/method also includes an

assembly/step in which the overlapped layers of the first layer are connected together separate from a central portion of the first layer.

According to another broad aspect of the invention, a machine/method includes a first shaping device/step, a second shaping device/step, a connecting assembly/step, and an inner feed assembly/step. The first shaping device/step shapes a first layer of the stock material into a casing with its lateral edge portions being brought into overlapping relationship one inside the other. The second shaping device/step shapes at least a second layer of the stock material into a stuffing for the casing. The connecting assembly/device is positioned/performed downstream of the first shaping device/step and connects the overlapped portions of the first layer. The inner feed assembly/step is positioned/performed downstream of the second shaping device/step and feeds the second layer into the interior of the casing.

According to another broad aspect of the invention, a machine/method includes a forming assembly/step, a connecting assembly/step, and a guiding device/step. The forming assembly/step shapes the plural layers of the stock material into a three-dimensional strip of dunnage having central portions and overlapped edge portions. The connecting assembly/step is positioned/performed downstream of the forming assembly/step and connects the overlapped lateral edge portions of the layers separately from the central portions of the layers. The guiding device/step directs the central portions of the layers away from the connecting assembly to prevent the central portions from passing through the connecting assembly.

One particular cushioning conversion machine according to the present invention includes a first shaping device which shapes a first layer of the stock material into a casing with the lateral edge portions being brought into overlapping relationship one inside the other, a second shaping device which shapes at least one second layer of the stock material into a stuffing for the for the casing, a connecting assembly downstream of the first shaping device for connecting the overlapped lateral edge portions of the first layer separate from the stuffing, and an inner feed assembly downstream of the second shaping device for feeding the second layer into the interior of the casing. The machine further comprises an outer feed assembly for engaging and feeding a central portion of the first layer, the outer and connecting assemblies being cooperative to pull the first layer through the first shaping device. The outer feed assembly and the connecting assembly engage the first layer at transversely aligned locations relative to a movement path of the first layer. The connecting assembly includes a pair of rotating connecting members forming therebetween a nip through which the overlapped lateral

edge portions of the first layer pass, the outer feed assembly includes a pair of rotating feed members forming therebetween a nip through which the central portion of the first layer passes, and the inner feed assembly includes a pair of rotating crumpling members forming therebetween a nip though which the second layer or layers pass and are crumpled thereby. The rotating crumpling members of the inner feed assembly are mounted to downstream ends of respective supports attached in cantilever-like manner to a frame structure of the machine. The supports respectively extend on opposite sides of the second shaping device from an upstream end of the first shaping device to a downstream end of the first shaping device, and an inner one of the rotating connecting members of the connecting assembly and an inner one of the rotating feed members of the outer feed assembly are respectively mounted to the downstream ends of the supports. The rotating crumpling members of the inner feed assembly are driven by the rotating members of either the outer or connecting assemblies, which have the outer rotating member thereof driven by a feed motor. An outer one of the rotating connecting members or an outer one of the rotating feed members is mounted to the frame for movement transversely to the path of the stock material. The outer connecting or feed member is resiliently biased towards the inner connecting or feed member for resiliently constraining the downstream end of a respective one of the supports against movement away from the downstream end of the other support, whereby one of the rotating crumpling members of the inner feed assembly will be resiliently constrained against movement away from the other crumpling member. The first shaping device includes a folding device having converging side walls and respective wings inwardly turned toward one another, the wings being overlapped and spaced apart. An outer one of the overlapped wings defines with an inner one of the wings a first area for receiving one edge portion of the first layer of stock material, and the second shaping device has a surface defining with the inner one of the wings a second area for receiving an opposite edge portion of the first layer. The folding device further includes an inner folder surface and an outer center guide surface extending laterally between the side wall and defining therebetween a passage for the central portion of the first layer, and the inner folder surface has side edges spaced from the side walls. There is provided at least one roller which holds the first layer against an upstream end portion of the inner folder surface and edge guides extending generally perpendicular to the inner folder surface and spaced from the side edges of the inner folder surface at a location downstream of the upstream end portion of the inner folder surface and upstream of the side walls of the folding device. The second shaping

device includes a converging chute and a former which cooperate to turn inwardly the edges of the second layer to form a pillow-like stuffing. The converging chute may be mounted between the aforesaid cantilevered supports.

Another particular cushioning conversion machine according to the present invention comprises a forming assembly which shapes plural layers of the stock material into a continuous three dimensional strip of dunnage having central portions and overlapped edge portions, a connecting assembly downstream of the forming assembly for connecting the overlapped lateral edge portions of the layers separately from central portions of the layers, and a guide which directs the central portions of the layers away from connecting assembly to prevent the central portions from passing through the connecting assembly. The connecting assembly includes a pair of rotating connecting members forming therebetween a nip through which the overlapped lateral edge portions of the first layer pass. The machine a frame structure, and the forming assembly includes a chute and a former extending into the chute, with one rotating member being mounted to a downstream end of the former interiorly of the path of the stock material and the other, which is rotatably driven, being mounted to the frame structure independently of the former and externally of the path of the stock material. More particularly, the one rotating member is mounted to a downstream end of a bracket connected to the former in cantilever-like manner and projecting through and beyond a downstream end of the chute. Moreover, the guide includes a finger projecting forwardly from the former to a point at least partially overlapping the rotating connecting members relative to the movement path of the stock material through the machine.

Also according to broad aspects of the invention, cushioning products are provided.

According to one broad aspect, a cushioning product comprises plural layers of sheet-like stock material folded upon themselves. At least an outer layer of the plural layers has lateral edge portions overlapped and connected together separate from a central portion of the outer layer. The overlapped lateral edge portions of the outer layer are generally coplanar with adjacent unoverlapped portions of the outer layer.

According to another broad aspect, a cushioning product comprises plural layers of sheet-like stock material folded upon themselves. An outer layer of the plural layers has lateral edge portions overlapped and connected together separate from a central portion of the outer layer. The remaining inner layers of the plural layers also have lateral end

portions overlapped and connected together separate from their respective central portions.

According to another broad aspect, a cushioning product comprises plural layers of sheet-like stock material folded upon themselves. An outer layer of the plural layers has lateral edge portions overlapped and connected together separate from a central portion of the outer layer. The remaining inner layers of the plural layers also have lateral end portions overlapped and connected together with the overlapped lateral edge portions of the outer layer.

In any of these machines, methods, or products, the plural layers of stock material may comprise biodegradable, recyclable, and reusable Kraft paper.

The foregoing and other features of the invention are hereinafter fully described and particularly pointed out in the claims, the following description and annexed drawings setting forth in detail a certain illustrative embodiment of the invention, this embodiment being indicative, however, of but one of the various ways in which the principles of the invention may be employed.

Figure 1 is a side view of a cushioning conversion machine according to the invention with the side wall of the machine's housing nearest the viewer broken away to permit viewing of internal machine components.

Figure 2 is a plan view of the conversion machine with the wall of the housing nearest the viewer broken away to permit viewing of internal machine components.

Figures 3-6 are sectional views of the machine of Figure 1 respectively taken along the lines 3-3, 4-4, 5-5 and 6-6 of Figure 1.

Figure 7 is an enlarged fragmentary portion of Figure 1.

Figure 8 is a schematic perspective view of a cushioning product according to the present invention.

Figure 9 is a side view of another cushioning conversion machine according to the invention with a side panel of the machine's housing nearest the viewer removed to permit viewing of internal machine components.

Figure 10 is a partial plan view of the conversion machine with the top panel of the housing partly broken away to permit viewing of internal machine components.

Figure 11 is a plan view of the modified former used in the machine of Figure 9.

Figure 12 is a side view of the modified former used in the machine of Figure 9.

Figure 13 is a front end view of the modified former used in the machine of Figure 9.

Figure 14 is a plan view of the modified chute used in the machine of Figure 9.

Figure 15 is a side view of the modified chute used in the machine of Figure 9.

Figure 16 is a front end view of the modified chute used in the machine of Figure 9.

Figure 17 is a sectional view through the stitching gears used in the machine of Figure 9.

Figure 18 is a side view of the stitching gears used in the machine of Figure 9.

Figure 19 is a schematic illustration of another cushioning product according to the invention.

Figure 20 is a cross-sectional view taken along the line 20-20 of Figure 19.

Referring now to Figures 1 and 2, an exemplary embodiment of a cushioning conversion machine according to the invention is designated generally by reference numeral 30. The machine includes a housing 31 which forms the structural skeleton for the conversion assemblies of the machine 30. The conversion assemblies include a stock supply assembly 32, a forming assembly 33 composed of an outer shaping assembly 34 and an inner shaping assembly 35, feed assemblies 36 powered by a feed motor 37, a cutting assembly 38 powered by a cut motor 39, and a post-cutting constraining assembly 40. These assemblies of the machine 30 cooperate to convert sheet-like stock material into a cushioning product according to the present invention. The roles the conversion assemblies and components thereof play in the creation of such a cushioning product are explained below in detail. In regard to the various functions performed by the noted assemblies and components thereof, the terms (including a reference to a "means") used to identify the herein-described assemblies and devices are intended to correspond, unless otherwise indicated, to any assembly/device which performs the specified function of such an assembly/device, that is functionally equivalent even though not structurally equivalent to the disclosed structure which performs the function in the illustrated exemplary embodiment of the invention.

The illustrated machine 30, representing a preferred embodiment of the invention, is designed to convert multi-layer stock material into a cushioning product. Preferably, the stock material comprises at least two and preferably three or more superimposed layers which may be supplied in the form of a stock roll. These layers are each preferably 27-30 inches wide, and comprised of biodegradable, recyclable and reusable 30-50 pound Kraft paper.

The housing 31 includes a base plate or wall 42, side plates or walls 44, and an end plate or wall 46 which collectively form a frame structure to which the conversion

assemblies of the machine are mounted. The base wall 42 is generally planar and rectangular in shape. The housing also includes a top wall 45, which together with the base, side and end walls, form an enclosure. All or a part of the top wall may be in the form of an openable cover for permitting easy access to the components of the machine located inside the housing. As shown in Figure 2, the motors 37 and 39 are mounted on the base wall 42 which may be provided with a transverse mounting plate 47 which forms part of the base wall or plate 42. The motors are disposed on opposite sides of the forming assembly 33.

The end plate 46 extends perpendicularly from a location near, but inward from, the downstream end of the base wall 42. It should be noted that the terms "upstream" and "downstream" are herein used in relation to the direction of flow of the stock material through the machine 30. The end plate 46 is generally rectangular and planar and includes a dunnage outlet opening. The housing (or frame) 31 also includes a front cover or plate 49 which extends perpendicularly from the downstream edge of the base wall 42. Thus, the end plate 46 and front plate 49 bound upstream and downstream ends of a box-like extended portion of the downstream end of the housing 31. The front plate 49 may be a door-like structure which may be selectively opened to access cutting assembly components of the cutting assembly 38. The post cutting constraint 40 may be mounted to the front plate 49 and includes a tubular portion generally corresponding in cross-section to the cushioning product produced by the machine.

The base and side walls 42 and 44 have at the upstream end of the housing 31 inturned edge portions that form a rectangular border around a centrally located, and relatively large, rectangular stock inlet opening 51. This border may be viewed as an end plate or wall extending perpendicularly from the upstream edge of the base wall 42 and to which the stock supply assembly 32 is attached.

The illustrated stock supply assembly 32, thus located at the rear or upstream end (to the left in Figures 1 and 2) of the machine 30, includes a holder assembly 54 for a stock roll 55. The illustrated stock roll consists of three superimposed plies or layers 56-58 of biodegradable, recyclable and reusable thirty-pound Kraft paper rolled onto a hollow cylindrical tube. The stock roll may be supported by a spindle 60 or other stock roll holder device, such as that shown in U.S. Patent Application No. 08/267,960 between the lower ends of a pair of hanger brackets 61 provided, as shown, with slots 62 for receiving the ends of the spindle. The illustrated hanger brackets 61 (or hangers) have a double L or stepped configuration for use with the machine 30 when supported in a horizontal orientation as shown. It will be appreciated

that the machine 30 may be otherwise oriented, such as vertically or at an incline, for different applications. Also, the stock roll holder assembly 54 need not be mounted to the machine housing as shown, but instead may be separate from the machine housing as in the form of a cart, especially when large and thus heavy stock rolls are used.

The upper risers or legs 63 of the stock roll hangers 61 are secured to the rear wall of the housing 31. The intermediate legs 64 extend horizontally away from the housing and the lower legs 65 depend from the outer ends of the intermediate legs. The hangers have journalled therebetween guide rollers 67 and 68 over which the superimposed layers of stock material are trained. Between the stock roll 55 and first guide roller 67, the superimposed layers of stock material are passed around a damper roller 70 which is biased to exert a tensioning force on the stock material being fed into the machine. In the illustrated embodiment, the damper roller is journalled between the ends of pivot arms 71 pivotally attached at 72 to the hangers 61, and the damper roller is biased by gravity, although other biasing arrangements may be used such as resilient spring biasing means. The dancer roller pivots about the pivot 72 of the pivot arms as the tension on the stock material is increased or decreased during unwinding of the stock material from the stock roll. This pivoting action, combined with the serpentine path determined by the guide rollers 67 and 68, dampens the effects of starting and stopping of the stock material feed mechanisms (hereinafter described) and thereby assists in maintaining a more uniform tension on the stock material.

From the guide roller 68, one layer 56 of the stock material, herein also referred to as an outer or first layer, passes to the entry or upstream end of the outer shaping assembly or device 34. The other layer or layers 57 and 58 of stock material, herein also referred to as an inner or second layer or layers, passes to separators 75-77 which separate the plies from one another. As shown, the separators are rollers journalled between the upper legs 63 of the hangers 61. From the separators, the inner layers pass to the entry end of the inner shaping assembly 33.

The inner shaping assembly shapes the inner layers of stock material into a stuffing for a tubular casing as the inner layers are fed through the inner shaping assembly by an inner feed assembly 80 that constitutes one of the aforesaid feed assemblies. In the illustrated embodiment the inner feed assembly is located downstream of the inner shaping assembly and thus pulls the inner layer through the interior of the inner shaping assembly.

With reference to Figures 1, 2, 4 and 5, the inner shaping assembly 33 includes a shaping chute 82 and a former 83 which cooperate to turn inwardly the edges of the

inner layers to form a strip of pillow-like stuffing. The illustrated shaping chute (a converging chute as the cross section of the chute progressively decreases) and former are of the type shown in U.S. Patent Application No. 08/386,355. As will be appreciated, the converging chute has side walls which turn towards one another to roll lateral edge portions of the inner layers toward one another. In addition to this rolling action, the inner layers will crumple because of the progressively decreasing cross-section of the converging chute. The former 83 is in the form of a hair pin with one leg extending generally parallel with a center guide wall of the converging chute to define a relatively narrow guide channel for the center portion of the inner layers moving through the converging chute, whereby the center portion is held in close proximity to said center guide wall. The other leg of the hair pin is attached to the wall of the chute opposite the center guide wall and the former preferably has a rounded upstream end as shown in Figure 1 for providing a smooth guide-in for the center portion of the inner layers.

The chute 82 is mounted between a pair of supports 90 and 91 herein referred to as the upper and lower supports in view of their relative positions shown in the drawings and not to limit the machine to a horizontal orientation. As best shown in Figures 1 and 3, the upper support 90 is attached at its upstream end in cantilever-like manner to a short post 92 on a transverse frame member 94 extending between the side walls 44 of the housing 31. The lower support 91 is similarly attached at its upstream end in cantilever-like manner to a short post 96 secured to the bottom wall 42 of the housing. From their respective points of attachment, the cantilevered supports extend downstream in generally parallel, but slightly converging, relationship as shown in Figure 1. The chute may be attached on opposite sides thereof (top and bottom in Figure 1) to the upper and lower supports. Looking at Figure 1, it will be appreciated that the transverse frame member 94 is offset from the path of the inner layers 57 and 58 from the separators 75-77 to the inner shaping assembly 33. For increased stiffness and strength, the supports preferably are fabricated as U-shape channel members having outwardly turned ears at the ends of the legs of the channel, as best shown in Figure 5. The outwardly turned ears may provide for attachment to another member in the case of the upper support or may cooperate to form part of a guide surface for a layer of stock material passing thereover in the case of the lower support.

For feeding the inner layers through the inner shaping assembly 33, the inner feed assembly, as best shown in Figures 6 and 7, includes a pair of rotating crumpling members 100 and 101 forming therebetween a nip through which a central region or

band of the strip of stuffing formed from the inner layers pass and which is further crumpled and preferably loosely connected. The crumpling members preferably are toothed gear-like members similar to the gear-like members shown in U.S. Patent No. 4,750,896. The crumpling members are mounted for rotation by shafts 102 and 103 extending between clevis-like extensions 104 and 105 at the downstream ends of the supports 90 and 91. As described further below, at least one of the crumpling members is rotatably driven, in this case the crumpling member 100. The supports hold the crumpling members with the teeth thereof in loosely meshed relationship for crumpling and loosely connecting the inner layers passing therebetween. As is preferred, the inner layers are looseiy connected such that they can separate somewhat within the tubular casing formed therearound in the hereinafter described manner. This adds to the loft or reduced density of the finished cushioning or dunnage product.

Because of the length and an inherent resilient flexibility of the cantilever supports 90 and 91 (and the chute 82 which may be disposed therebetween), the crumpling members 100 and 101 are free to float towards and away from one another to accommodate different thicknesses of stock material between the crumpling members. Preferably, the amount of squeeze pressure applied by the crumpling members is adjustably controlled in the manner hereinafter described in connection with the outer shaping assembly to obtain a desired crumpling and loose connecting action.

Referring now to Figures 1-5, the outer shaping assembly 34 shapes the outer layer of the stock material into a tubular casing with the lateral edge portions being brought into overlapping relationship as the outer layer is fed through the outer shaping assembly by outer feed assemblies 108 and 109. In the illustrated embodiment the outer feed assemblies are located downstream of the outer shaping assembly and thus pull the outer layer through the interior of the outer shaping assembly. The outer shaping assembly includes a folding device 110 including an outer folding channel 111 and an inner folding plate 112 extending into the folding channel. The folding channel has converging side walls 113 and 114 depending from a laterally extending guide wall 115 which together form an inverted U-shape as best seen in Figure 5.

The folding plate 112 has a rounded upstream or entry end over which the central region of the outer layer passes. The upstream end of the inner folding plate is narrower than the width of the outer layer such that lateral edge portions of the outer layer overhang the sides of the folding plate. From its upstream end the folding plate tapers to its narrower downstream end which has a width greater than the width of the downstream end of the converging chute 82 as best shown in Figure 2. Also, the

upstream end of the inner folding plate has a width less than the width of the downstream end of the folding channel such that the edges of the folder plate are spaced from the adjacent side walls 113 and 114 of the folding channel 111.

The outer layer is held against the rounded entry end of the folding plate 112 by a folder roller or rollers 118 which, in the illustrated embodiment, are held by gravity against the folding plate. As shown, two rollers are rotatably mounted on an axle or shaft 119 which extends transversely between the free ends of a pair of pivot arms 120. The pivot arms have their other ends pivotally connected to a transverse member 122 extending between the side walls 44 of the machine housing 31. This arrangement enables the folder rollers to be easily lifted clear of the inner folding plate to facilitate threading of the outer layer therebetween during loading on the machine.

The folder roller or rollers 118 preferably have annular flanges 124 (Figures 2 and 3) at the outer sides thereof which overhang respective side edges of the folder plate 112 for urging downwardly the lateral edge portions of the outer layer overhanging the folder plate. Further downward urging or folding of the lateral edge portions is effected by edge guides 126 (Figures 1, 2 and 4) extending generally perpendicularly to the folder plate and spaced from respective side edges of said folder plate at a location downstream of the upstream end portion of the folder plate and upstream of the side walls 113 and 114 of the folding channel 111. The edge guides, preferably rollers, assist in guiding the edge portions of the outer layer inwardly of the side walls of the folding channel while the central region of the outer layer is guided between the outer surface of the folder plate 112 and inner surface of the guide wall 115 of the folding channel, which guide wall preferably has an upstream extension extending to approximately the upstream end of the folder plate as best shown in Figure 1. As also shown in Figure 1, the guide wall and folder plate preferably converge towards one another going form their upstream to their downstream ends.

The side walls 113 and 114 of the folding channel 111 have along their edges opposite the guide wall 115 respective wings 130 and 131 inwardly turned toward one another as best shown in Figures 1, 2 and 5. The wings, which are triangular in shape, have the downstream ends thereof overlapped (see the broken line profile in Figure 2) and spaced apart (Figures 1 and 5). The outer one 131 of the overlapped wings defines with the inner one 130 of said wings a first area for receiving one folded under edge portion of the outer layer of stock material, and the inner one of the wings defines with an outer surface of the shaping chute 82 a second area for receiving an opposite edge portion of the outer layer. Preferably, the wings converge toward the inner folder plate

and guide wall. As the outer layer passes through the folding device, the outer lateral edge portions of the outer layer are folded in upon themselves to form a tubular casing surrounding the strip of stuffing exiting from the inner feed assembly.

For feeding the outer layer through the outer shaping assembly 34, the outer feed assembly 108, as best shown in Figures 6 and 7, includes a pair of rotating feed members 134 and 135 forming therebetween a nip through which a central region of the outer layer passes. The rotating feed members 134 and 135 preferably are toothed gear-like members similar to the gear-like members shown in U.S. Patent No. 4,750,896. The inner rotating feed member 135 is mounted for rotation by a shaft 137 extending between the ears of the adjacent clevis-like extension 104 at the downstream end of the cantilevered support 90. The outer rotating feed member 134 is mounted to a shaft 138 which has the ends thereof supported in laterally spaced apart pillow blocks 140 which, if desired, may be joined together, as such by a laterally extending member, for uniform translating movement. The pillow block housings 140 are secured to the front plate 46 of the housing 31 by fasteners such as bolts 142 guided in respective slots 144 extending perpendicular to the path of the outer layer between the rotating feed members. Accordingly, the outer rotating feed member is movable transversely to the path of the outer layer. Each pillow block (bearing) housings, and thus the outer rotating feed member, is biased inwardly toward the inner rotating feed member by suitable resilient biasing means such as a spring 146 attached between the bearing housing and confronting housing structure as illustrated in Figures 6 and 7. As will be appreciated, the resilient biasing force acts through the meshing rotating feed members 134 and 135 to resiliently constrain outward flexing of the free end of the cantilevered support 90 and thus the respective rotating crumpling member 100.

The outer rotating feed member 134 is driven by the feed motor 37 (Figure 1) in well known manner using a suitable drive train, which may include for example a chain 148 trained around a sprocket 149 on the shaft 138 and a driven sprocket 150, with a suitable resiliently biased take-up device (not shown) being used to take-up play in the chain that arises from movement of the shaft sprocket 149 relative to the driven sprocket 150. The outer rotating feed member 134 will rotatably drive the inner rotating feed member 135. The inner rotating feed member 135 is also meshed with the relatively adjacent one of the crumpling members 100 of the inner feed assembly 80 whereby such crumpling member will be rotatably driven synchronously with the outer feed assembly for feeding of the inner layers.

The other outer feed assembly 109 is similar to the feed assembly 108, but is referred to herein as the connecting assembly because it functions to connect together the overlapped lateral edge portions of the outer layer. The connecting assembly 109 includes a pair of rotating connecting members 155 and 156 forming therebetween a nip through which the overlapped lateral edge portions of the outer layer pass. The rotating connecting members preferably are toothed gear-like members of the type described in commonly assigned U.S. Patent No. 4,968,291, or any other pair of rotating devices that provide for secure stitching together of the outer layer edge portions. The gear-like members or gears shown in this patent operate to perforate or coin the overlapped lateral edge portions along a central band. Although not required or necessary desired for the rotating members of the other feed assemblies, the connecting members 155 and 156 operate to provide a secure mechanical interference interlock between the overlapped lateral edge portions of the outer layer to form a connected tubular casing for the stuffing that has substantial holding resistance to "unzippering" of the thus formed stitched seam.

The inner rotating connecting member 156 is mounted for rotation by a shaft 158 extending between the ears of the adjacent clevis-like extension 105 at the downstream end of the cantilevered support 91. The outer rotating connecting member 155 is mounted to a shaft 159 which has the ends thereof supported in laterally spaced apart bearing housings 160. The bearing housings are essentially the same as the above described bearing housings 140 and are similarly mounted to the front plate 46 by bolts 161 guided in respective slots 162 extending perpendicular to the path of the outer layer between the rotating connecting members. Each bearing housing 160 is biased inwardly toward the inner rotating connecting member by a spring 164. As will be appreciated, the resilient biasing of the spring forces acts through the meshing rotating connecting members 155 and 156 to resiliently constrain outward flexing of the free end of the cantilevered support 91 and thus the respective rotating crumpling member 101. Thus, the free ends of both cantilevered supports 90 and 91 are resiliently constrained against outward flexing. However, it will be appreciated that such resilient constraint may also be effected even if the bearing mounts for one of the shafts 138 and 159 is fixed against movement relative to the frame. The amount of squeeze pressure applied by the crumpling members is adjustably controlled by adjusting the biasing force of the springs 146 and 164.

As shown in Figures 6 and 7, the shaft 159 is rotatably driven by the feed motor through a suitable drive train which may include a chain 165 trained around a sprocket

on the shaft 159 and a driven sprocket, with a resiliently biased take-up being provided to accommodate movement of the shaft 159. Also, the sprocket 150 may be mounted to the shaft 159 as an expedient means for effecting synchronous rotation of the rotating members of the outer feed and connecting assemblies 108 and 109. As is further evident from Figure 7, the outer feed assembly 100 and the connecting assembly 109 engage the outer layer at transversely aligned locations relative to a movement path of the first layer.

Although details of the method of forming a dunnage product according to the invention have been mentioned above in connection with the description of the structure of the machine, by way of summary a method according to the invention comprises the steps of shaping an outer layer of the stock material into a tube with the lateral edge portions being brought into overlapping relationship, connecting the overlapped lateral edge portions of the outer layer to form a tubular casing, shaping an inner layer or layers of the stock material into a stuffing for the for the casing, and feeding the stuffing into the interior of the casing. The overlapped lateral edge portions are generally coplanar with adjacent unoverlapped portions of said outer layer during the connecting step. Preferably, the layers of stock material comprise biodegradable, recyclable and reusable Kraft paper. Also, as is apparent from the foregoing description, the step of connecting the overlapped lateral edge portions includes using a pair of rotating connecting members forming therebetween a nip through which the overlapped lateral edge portions of the outer layer pass. Moreover, the feeding step uses the pair of rotating crumpling members forming therebetween a nip though which the inner layer or layers pass and are crumpled thereby.

The cutting assembly 38 is used to cut the thus produced continuous strip at a desired length to form a cushioning product. In this manner, the length of the cushioning product may be varied depending on the intended application. The particular construction and operation of the strip-cutting assembly is not essential to the present invention. However, reference may be had to U.S. Patent Application No. 08/110,349 for a cutting assembly similar to that illustrated.

Referring now to Figure 8, a cushioning product according to the invention is schematically illustrated at 175. The cushioning product 175 comprises at least and preferably two, three or more inner layers 57 and 58 of sheet-like material having portions thereof folded upon themselves and crumpled to produce a stuffing 176 loosely connected along central band 177, and an outer layer 56 of sheet-like material formed into a tubular casing 179 surrounding the stuffing and having lateral edge

portions overlapped and stitched together along a central band 180 separate from the stuffing 176. The overlapped lateral edge portions are generally coplanar with adjacent unoverlapped portions of the first layer, and the layers of stock material comprise biodegradable, recyclable and reusable Kraft paper, as above mentioned.

Referring now to Figures 9 and 10, an exemplary embodiment of a cushioning conversion machine according to the invention is designated generally by reference numeral 1030. The machine includes a housing 1031 which forms the structural skeleton for the conversion assemblies of the machine 1030. The conversion assemblies include a stock supply assembly 1032, a forming assembly 1033, a feed/connecting assembly 1036 powered by a feed motor 1037, and a cutting assembly 1038. These assemblies of the machine 1030 cooperate to convert sheet-like stock material into a cushioning product according to the present invention. The roles the conversion assemblies and components thereof play in the creation of such a cushioning product are explained below in detail. In regard to the various functions performed by the noted assemblies and components thereof, the terms (including a reference to a "means") used to identify the herein-described assemblies and devices are intended to correspond, unless otherwise indicated, to any assembly/device which performs the specified function of such an assembly/device, that is functionally equivalent even though not structurally equivalent to the disclosed structure which performs the function in the illustrated exemplary embodiment of the invention.

The illustrated machine 1030, representing a preferred embodiment of the invention, is designed to convert multi-layer stock material into a cushioning product. Preferably, the stock material comprises at least two and preferably three or more superimposed layers which may be supplied in the form of a stock roll. These layers are each preferably 27-30 inches wide, and comprised of biodegradable, recyclable and reusable 30-50 pound Kraft paper.

The housing 1031 includes a frame 1042 to which the conversion assemblies of the machine are mounted. The frame includes upright legs and various cross frame members similar to the frame found in the well known PADPAK machines provided by Ranpak Corp. of Concord, Ohio. However, it will be appreciated that the invention may be applied to other types of machines. The housing preferably has an outer sheet metal skin enclosing the interior conversion assemblies of the machine. The top wall of the housing may include an openable cover for permitting easy access to the components of the machine located inside the housing.

The illustrated stock supply assembly 1032, located at the rear or upstream end (to the left in Figures 9 and 10) of the machine 1030, includes a holder assembly 1054 for a stock roll 1055. The illustrated stock roll consists of three superimposed plies or layers 1056-1058 of biodegradable, recyclable and reusable thirty-pound Kraft paper rolled onto a hollow cylindrical tube. The stock roll may be supported by a spindle 1060 or other stock roll holder device, such as that shown in U.S. Patent Application No. 08/267,960, between the lower arms of a pair of brackets 1061 provided, as shown, with slots 1062 for receiving the ends of the spindle. The stock roll holder assembly 1054 need not be mounted to the machine housing as shown, but instead may be separate from the machine housing as in the form of a cart, especially when large and thus heavy stock rolls are used.

The brackets 1061, which are secured to the rear of the housing 1031, have upper arms 1064 extending horizontally away from the housing and terminating at depending arms 1065. The upper and depending arms have journalled therebetween guide rollers 1067 and 1068 over which the superimposed layers of stock material are trained. Between the guide rollers, the superimposed layers of stock material are passed over a splicing plate 1070 extending transversely between the depending arms 1065. The depending arms also have paper clamps 1072 mounted thereto on opposite sides of the path of the stock material. The paper clamps are spring biased against an adjacent clamping surface and are rotatable from a position clear of the stock material path to a position overlaying the stock material path, such that when released the clamps are operative to hold the stock material to the clamping surface downstream of the splicing plate 1070. It is noted that the terms "upstream" and "downstream" are herein used in relation to the direction of flow of the stock material through the machine 1030. When the trailing ends of the layers of a spent stock roll are thus held, the leading ends of the layers of a next stock roll may be spliced to the trailing ends. The splicing plate provides a surface along which the layer ends may be cut to provide straight edges for splicing.

From the guide roller 1068, the layers of stock material pass to separators 1075-1077 which separate the plies from one another. The separators preferably are rollers journalled between the upper arms 1064 of the brackets 1061. From the separators, the layers of the stock material pass to the entry end of the forming assembly 1033. The forming assembly 1033 includes a shaping chute 1082 and a former 1083 which cooperate to turn inwardly the edges of the layers to form a tubular strip of cushioning. The illustrated shaping chute (a converging chute as the cross section of the chute

progressively decreases) and former generally are of the type shown in U.S. Patent Nos. 4,717,613 and 4,750,896.

As best shown in Figures 14-16, the converging chute 1082 has side walls 1084 which turn towards one another to roll lateral edge portions of the inner layers toward one another. In addition to this rolling action, the inner layers will crumple because of the progressively decreasing cross-section of the converging chute. The chute is modified from previously used chutes by providing a more downwardly sloped bottom wall 1085 to allow the central portions of the layers to exit the downstream end of the chute at a lower elevation spaced further from the overlapped lateral edge portions of the strip. As best shown in Figures 11-13, the former 1083 is in the form of a triangular frame having open U-shape guide surfaces 1088 and 1089 of progressively decreasing height and width going from the upstream to the downstream end of the former.

As shown in Figures 9 and 10, the former extends into the converging chute through the wider end thereof with the nose 1090 of the former positioned at about the downstream end of the converging chute. The former is mounted in known manner to the frame by adjustable posts 1092 and further is provided with various stiffening members 1093 as needed to rigidly support the former and portions thereof.

The converging chute 1082 and former 1083 cooperate in well known manner to roll the layers of stock paper inwardly and bring the lateral edge portions thereof into overlapping relationship to form an unconnected strip of cushioning for passage to the feed/connecting assembly 1036. In the illustrated embodiment of the invention, the feed/connecting assembly functions to connect together the overlapped lateral edge portions of the layers as well as to feed the stock material through the machine. The feed/connecting assembly includes a pair of gear-like members 1100 and 1102, often simply referred to a gears, forming therebetween a nip through which pass the overlapped lateral edge portions of the layers of stock material. The rotating connecting members may be toothed gear-like members of the type described in commonly assigned U.S. Patent No. 4,968,291, or any other pair of rotating devices that provide for secure stitching together of the outer layer edge portions, such as the hereinafter described preferred embodiment of stitching gears.

The upper gear 1100 is rotatably mounted to the frame 1042 and rotatably driven by the feed motor 1037 through a chain drive mechanism 1103. The lower gear 1102 is mounted in a clevis 1105 formed at the downstream end of a mounting bracket 1106 attached to the nose end of the former 1083 as best shown in Figures 11-13.

The mounting bracket is sufficiently narrow such that the side portions of the layers may be folded therearound into a tubular shape and the laterally outer edge portions brought into an interleaved overlapping relationship prior to passage of such overlapped edge portions between the gears. As the overlapped edge portions are pulled between the gears, they are stitched together by the gears and thereby connected to resist opening or unzippering of the strip which may be detrimental to its cushioning and/or handling properties.

Unlike the conversion machines shown in the aforesaid U.S. Patents wherein both the edge portions and center portions of the layers are all passed between the gears, in accordance with the present invention only the overlapping edge portions of the layers are passed between the rotating gears while the center portions of the layers are guided along a path outside of the rotating gears. To this end, a guide finger plate 1110 is mounted to the bracket 1106 to push the center portions of the layers downwardly and clear of the rotating gears 1100 and 1102 for passage along a bottom guide plate 1112 which supports the center portion of the layers. The guide figure plate extends to a point partially underlying the gear 1102 sufficiently to prevent the center portions of the layers from being drawn into the nip of the gears. A top guide 1114 may also be provided as shown.

As a result of the foregoing, all of the overlapped edge portions are stitched together independently (separately) of the center portions of the layers. This adds to the loft or reduced density of the finished cushioning or dunnage product. If desired, the center portions of the layers may be advanced by a second pair of rotating gears, as in a manner similar to that described herein.

The cutting assembly 1038 is used to cut the thusly produced continuous strip at a desired length to form a cushioning product. In this manner, the length of the cushioning product may be varied depending on the intended application. The particular construction and operation of the strip-cutting assembly is not essential to the present invention. However, reference may be had to U.S. Patent Application No. 08/386,355 for a cutting assembly similar to that illustrated, or to U.S. Patent Application No. 08/110,349 for another type of cutting assembly.

Referring now to Figures 17 and 18, details of the gears 1100 and 1102 can be seen. Although particularly useful in the above described machine, the gears may be used in place of the presently known gears (gear-like members in other conversion machines). It is noted that the new gear-like members may be used to perform both the stitching and feed functions previously performed by presently known gear-like

members, or just the stitching function while other means are provided to perform the feed function, such as one or more feed assemblies for pushing and/or pulling the stock material through the machine and/or sub-components thereof.

The gear 1102, herein also called the female stitching gear or wheel, has around the circumference thereof a plurality of radially outwardly extending projections 1120 preferably in the form of teeth, such as the illustrated spur gear teeth. The teeth 1120 are divided into a central segment 1122 and outer or side segments 1124 by annular recesses or grooves 1126. The segments and grooves preferably are symmetrically disposed with respect to the center plane 1128 of the female gear.

The other gear 1100, herein also referred to as the male stitching gear or wheel, includes a central segment 1130 and axially adjacent side segments 1132 herein referred to as punch or perforating segments. The central segment 1130 has around the circumference thereof a plurality of radially outwardly extending projections 1134, preferably teeth such as the illustrated spur gear teeth, meshing with the teeth 1120 of the central segment 1122 of the female stitching gear 1102. The punch segments 1132 each have around the circumference thereof a plurality of radially outwardly extending projections 1138 having a width slightly less than the width of the respective grooves 1126 in the female gear and thus dimensioned to be received in the annular grooves during rotation of the stitching gears. The projections 1138 on the punch segments 1132 have the same pitch as the teeth 1134 of the central segment 1130, but are offset circumferentially by one half pitch, whereby they are aligned with the spaces or valleys 1142 between the teeth 1134 of the central segment 1130 that receive the teeth 1120 of the female gear during rotation of the gears. Consequently, during rotation of the gears, the projections 1138 (or punches) will move past the synchronously moving teeth of the female stitching gear.

For easy fabrication of the male gear 1100, the punch segments 1132 may be formed on disc inserts 1141 attached to a main gear body 1143 including the central segment 1130, as shown. The punch segments have axially extended hubs 1146 fitted over axial hub projections at respective sides of the main gear body, with threaded holes 1148 being provided for receiving set screws which lock the inserts against rotation relative to the main gear portion. As also shown, the male gear is keyed to the driven shaft 1150 and the female gear may have a bushing 1152 in a centerbore thereof for rotating on its shaft. The hubs 1146 have an outer diameter equal the diameter of the base circle of the teeth 1134.

The edges of the punch segment projections 1138 (or at least the leading edges) preferably form with the sides thereof sharp corners which function as cutting or knife edges. Similarly, the edges (at least the leading edges) of the teeth 1120 of the female gear 1102 adjacent the annular grooves 1126 form sharp corners with the side walls of the grooves, also to function as a cutting or knife edges in cooperative relationship with the cutting edges of the punch segment projections.

As should now be evident, the gears 1100 and 1102 will rotate synchronously because of the meshed central segments of the gears which are about equal in width. The meshing gears pull the overlapped lateral edge portions of the stock material therebetween and while doing so will form dents or indentations in the stock material and thus thereby coin the stock material. At the same time, the punch segment projections will move past the teeth of the female gear. At the nip of the gear, the then juxtaposed punch segment projection 1138 and female gear tooth 1120 will cause the portions of the stock material radially outwardly thereof to move in opposite directions while the cutting edges cooperate to create a shearing action forming a slit through each one of the overlapped layers at each side of a thus formed tab portion being punched by the punch segment projection. To prevent tearing of the stock material other than at the slits, the several projections may be rounded at their radially outer ends.

Referring now to Figures 19 and 20, a cushioning product according to the invention is schematically illustrated at 1175. The cushioning product comprises at least two and preferably three, or more, layers 1177-1179 of sheet-like material having lateral edge portions thereof folded over the center portions and interleaved as seen at 1182. The overlapped and interleaved lateral edge portions 1182 are stitched together along a central seam or band 1183 separate from the central portions 1185 of the layers which are crumpled and provide loft to the cushioning product. The overlapped lateral edge portions 1182 are generally coplanar with adjacent unoverlapped portions of the first layer, and the layers of stock material comprise biodegradable, recyclable and reusable Kraft paper, as above mentioned.

As shown, the stitching pattern produced by the stitching gears includes a central row 1187 of outwardly directed dents 1188 alternating with a inwardly directed dents 1189. The central row of dents is bounded at each side thereof by a row 1190 of tabs 1191. The tabs, which are defined by laterally spaced apart slits 1193, are dented or punched from the layer of stock material in a direction opposite the relatively adjacent dent of the central row.

Although details of the method of forming the dunnage product according to the invention have been mentioned above in connection with the description of the structure of the machine, by way of summary a method according to the invention comprises the steps of shaping plural layers of the stock material into a tube with the lateral edge portions being brought into overlapping relationship and connecting the overlapped lateral edge portions of the outer layer separately from central portions of the layers. The overlapped lateral edge portions are generally coplanar with adjacent unoverlapped portions of the outer layer during the connecting step. Preferably, the layers of stock material comprise biodegradable, recyclable and reusable Kraft paper. Also, as is apparent from the foregoing description, the step of connecting the overlapped lateral edge portions includes using a pair of rotating connecting members forming therebetween a nip through which the overlapped lateral edge portions of the outer layer pass.

Although the invention has been shown and described with respect to certain preferred embodiments, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification. The present invention includes all such equivalent alterations and modifications.

CLAIMS

1. A cushioning conversion machine for converting plural layers of sheet-like stock material into a dunnage product, said machine comprising:

a forming assembly which shapes the plural layers into a three-dimensional strip of dunnage in which at least a first layer of the plural layers has overlapped edge portions which are generally coplanar with adjacent unoverlapped portions of the first layer; and

a connecting assembly which connects the overlapped layers of the first layer together separate from a central portion of the first layer.

2. A cushioning conversion machine as set forth in claim 1, wherein the forming assembly comprises a first shaping device which shapes the first layer into a casing having the overlapped edge portions and a second shaping device which shapes at least a second layer of the plural layers into a stuffing for the casing; and wherein the connecting assembly connects the overlapped edge portions of the first layer independent of the second layer.

3. A cushioning conversion machine as set forth in claim 2, further comprising an inner feed assembly downstream of the second shaping device for feeding the second layer into the interior of the casing.

4. A conversion machine as set forth in claim 3, further comprising an outer feed assembly for engaging and feeding a central portion of the first layer, said outer and connecting assembly being cooperative to pull the first layer through said first shaping device.

5. A conversion machine as set forth in claim 4, wherein said outer feed assembly and said connecting assembly engage the first layer at transversely aligned locations relative to a movement path of the first layer.

6. A conversion machine as set forth in claim 4, wherein said connecting device includes a pair of rotating connecting members forming therebetween a nip through which the overlapped lateral edge portions of the first layer pass, said outer feed assembly includes a pair of rotating feed members forming therebetween a nip through which the central portion of the first layer passes, and said inner feed assembly includes a pair of rotating crumpling members forming therebetween a nip though which the second layer passes and is crumpled thereby.

7. A conversion machine as set forth in claim 6, further comprising a frame structure; and wherein said rotating crumpling members of said inner feed assembly are mounted to downstream ends of respective supports attached in cantilever-like manner

to said frame and respectively extending on opposite sides of said second shaping device from an upstream end of said first shaping device to a downstream end of said first shaping device, and an inner one of said rotating connecting members of said connecting assembly and an inner of said rotating feed members of said outer feed assembly are respectively mounted to said downstream ends of said supports.

8. A conversion machine as set forth in claim 7, an outer one of said rotating connecting members or an outer one of said rotating feed members is mounted to said frame for movement transversely to the path of the stock material, and said outer connecting or feed member is resiliently biased towards said inner connecting or feed member for resiliently constraining the downstream end of a respective one of said supports against movement away from the downstream end of the other support, whereby one of the rotating crumpling members of said inner feed assembly is resiliently constrained against movement away from the other crumpling member.

9. A conversion machine as set forth in claim 7, an outer one of said rotating connecting members and an outer one of said rotating feed members are mounted to said frame for movement transversely to the path of the stock material, and said outer connecting and feed members are resiliently biased towards one another and respectively against said inner connecting and feed members for resiliently constraining the downstream ends of said supports against movement away from one another, whereby said rotating crumpling members of said inner feed assembly are resiliently constrained against movement away from one another.

10. A conversion machine as set forth in claim 6, wherein said rotating connecting members have a plurality of teeth interacting with the teeth on the other to stitch together the overlapped lateral edge portions.

11. A conversion machine as set forth in claim 10, wherein one of said rotating connecting members is rotatably driven by the other.

12. A conversion machine as set forth in claim 11, wherein said rotating connecting members have the teeth thereof in meshed relationship such that rotational motion of said one rotating connecting member is transmitted to the other rotating connecting member.

13. A conversion machine as set forth in claim 3, wherein said inner feed assembly includes a pair of rotating crumpling members forming therebetween a nip though which the second layer passes.

14. A conversion machine as set forth in claim 13, wherein said rotating crumpling members of said inner feed assembly are mounted to the downstream ends

of respective supports attached in cantilever-like manner to said frame and respectively extending on opposite sides of said second shaping device.

15. A conversion machine as set forth in claim 14, wherein said connecting assembly includes a pair of rotating connecting members form therebetween a nip through which the overlapped lateral edge portions of the first layer pass.

16. A conversion machine as set forth in claim 15, wherein said rotating connecting members have a plurality of teeth interacting with the teeth on the other to stitch the overlapped lateral edge portions together.

17. A conversion machine as set forth in claim 16, wherein one of said rotating connecting members is rotatably driven by the other.

18. A conversion machine as set forth in claim 17, wherein said rotating connecting members have the teeth thereof in meshed relationship such that rotational motion of said one rotating connecting member is transmitted to the other rotating connecting member.

19. A conversion machine as set forth in claim 18, including a pair of rotating members forming therebetween a nip through which a portion of the first layer passes, said rotating members having teeth thereon in meshed relationship such that rotational motion of an outer one of said rotating members is transmitted to an inner one of said rotating members, and said inner rotating member is drivingly connected to one of said rotating crumpling members of said inner feed assembly, whereby rotation of said outer rotating member rotates said inner rotating member which in turn effects rotation of said one rotating crumpling member.

20. A conversion machine as set forth in claim 13, wherein said rotating crumpling members of said inner feed assembly each have a plurality of teeth.

21. A conversion machine as set forth in claim 2, wherein said first shaping assembly includes a folding device having converging side walls and respective wings inwardly turned toward one another, said wings being overlapped and spaced apart.

22. A conversion machine as set forth in claim 21, wherein an outer one of said overlapped wings defines with an inner one of said wings a first area for receiving one edge portion of said first layer of stock material, and said second shaping device has a first surface defining with said inner one of said wings a second area for receiving on opposite edge portion of said first layer.

23. A conversion machine as set forth in claim 22, wherein said folding device further includes an inner folder surface and an outer center guide surface extending laterally between said side wall and defining therebetween a passage for the

central portion of said first layer, and said inner folder surface has side edges spaced from said side walls.

24. A conversion machine as set forth in claim 23, wherein said wings converge toward said inner folder and outer center guide surfaces.

25. A conversion machine as set forth in claim 23, including at least one roller which holds the first layer against an upstream end portion of said inner folder surface.

26. A conversion machine as set forth in claim 25, including edge guides extending generally perpendicular to said inner folder surface and spaced from said side edges of said inner folder surface at a location downstream of said upstream end portion of said inner folder surface and upstream of said side walls of said folding device.

27. A conversion machine as set forth in claim 2, further comprising at least one separator member interposed between the respective paths of the first and second layer upstream of said first and second shaping devices.

28. A conversion machine as set forth in claim 3, wherein said inner feed assembly includes a pair of rotating crumpling members forming therebetween a nip through which the second layer passes and is crumpled thereby.

29. A conversion machine as set forth in claim 28, further comprising a frame structure, and wherein said rotating crumpling members are mounted to downstream ends of respective supports attached in cantilever-like manner to said frame and respectively extending on opposite sides of said second shaping device from an upstream end of said first shaping device to a downstream end of said first shaping device.

30. A conversion machine as set forth in claim 29, wherein said second shaping device includes a converging chute mounted between said supports.

31. A conversion machine as set forth in claim 2, wherein said second shaping device includes a converging chute and a former which cooperate to turn inwardly the edges of the second layer to form a pillow-like stuffing.

32. A cushioning conversion machine as set forth in claim 1, wherein the forming assembly also shapes a second layer of the plural layers so that it has overlapped edge portions which are generally coplanar with adjacent unoverlapped portions of the second layer; and wherein the connecting assembly connects the overlapped portions of the second layer together with the overlapped portions of the first layer and separate from a central portion of the second layer.

33. A conversion machine as set forth in claim 32, wherein said connecting assembly includes a pair of rotating connecting members forming therebetween a nip through which the overlapped lateral edge portions of the first layer pass.

34. A conversion machine as set forth in claim 33, further comprising a frame structure; and wherein said forming assembly includes a chute and a former extending into said chute, one of said rotating members is mounted to a downstream end of said former interiorly of the path of the stock material and the other is mounted to said frame structure independently of said former and externally of the path of the stock material, and a drive is provided for rotatably driving said other of said rotating members.

35. A conversion machine as set forth in claim 34, wherein said rotating connecting members have a plurality of teeth interacting with the teeth on the other to stitch together the overlapped lateral edge portions, and wherein said machine further comprises a guide which directs the central portions of the layers away from the connecting assembly to prevent the central portions from passing through said connecting assembly, and wherein said guide includes a finger projecting forwardly from said former to a point at least partially overlapping said rotating connecting members relative to the movement path of the stock material through the machine.

36. A conversion machine as set forth in claim 34, further comprising at least one separator member interposed between the respective paths of the layers upstream of said forming assembly.

37. A conversion machine as set forth in claim 34, wherein said one of said rotating members is mounted to a downstream end of a bracket connected to said former in cantilever-like manner.

38. A conversion machine as set forth in claim 37, wherein said bracket projects through and beyond a downstream end of said chute.

39. A cushioning conversion machine for converting sheet-like stock material into a dunnage product, comprising

a first shaping device which shapes a first layer of the stock material into a casing with the lateral edge portions being brought into overlapping relationship one inside the other;

a second shaping device which shapes at least one second layer of the stock material into a stuffing for the for the casing;

a connecting assembly downstream of said first shaping device for connecting the overlapped lateral edge portions of the first layer; and

an inner feed assembly downstream of said second shaping device for feeding the second layer into the interior of the casing.

40. A cushioning conversion machine for converting sheet-like stock material into a dunnage product, comprising

a forming assembly which shapes plural layers of the stock material into a three dimensional strip of dunnage having central portions and overlapped edge portions;

a connecting assembly downstream of said forming assembly for connecting the overlapped lateral edge portions of the layers separately from central portions of said layers; and

a guiding device which directs the central portions of the layers away from connecting assembly to prevent the central portions from passing through said connecting assembly.

41. A method for converting plural layers of a sheet-like stock material into a dunnage product, said method comprising the steps of:

shaping the plural layers of the sheet-like stock material into a three-dimensional strip of dunnage in which at least an outer layer of said plural layers has overlapping lateral edge portions which are generally coplanar with adjacent overlapped portions of said outer layer; and

connecting the overlapped outer portions of the outer layer together separated from a central portion of the outer layer.

42. A method as set forth in claim 41 wherein said shaping step comprises folding at least one inner layer of the stock material upon itself to produce a stuffing and forming the outer layer into a tube surrounding the stuffing and wherein said connecting step connects the outer portions of the outer layer separate from the stuffing.

43. A method as set forth in claim 42, wherein said step of connecting the overlapped lateral edge portions includes using a pair of rotating connecting members forming therebetween a nip through which the overlapped lateral edge portions of the first layer pass.

44. A method as set forth in claim 43, wherein said feeding step includes using a pair of rotating crumpling members forming therebetween a nip though which the second layer passes and is crumpled thereby.

45. A method as set forth in claim 44 wherein said rotating connecting members have a plurality of teeth interacting with the teeth on the other to stitch together the overlapped lateral edge portions.

46. A method as set forth in claim 45, wherein one of said rotating connecting members is rotatably driven by the other.

47. A method as set forth in claim 46, wherein said rotating crumpling members of said inner feed assembly each have a plurality of teeth.

48. A method as set forth in claim 47, wherein said step of shaping a first layer includes using a folding device having converging side walls and respective wings inwardly turned toward one another, the wings being overlapped and spaced apart to fold the lateral edge portions of the first layer into overlapping relationship.

49. A method as set forth in claim 48, further including the step of supplying a plurality of second layers as a multi-ply stock material and then separating the second layers before said step of shaping second layers.

50. A method as set forth in claim 49, wherein said step of shaping said second layer includes passing said second layer through a converging chute.

51. A method as set forth in claim 50, wherein said step of shaping said second layer second includes using a former to shape the second layer and hold a central portion thereof adjacent one side of said converging chute.

52. A method as set forth in claim 41 wherein said folding step comprises folding the plural layers upon themselves in such a manner that at least one inner layer has overlapping lateral edge portions and wherein said connecting step comprises connecting the overlapping lateral edge portions of the inner layer together separate from a central portion of the inner layer.

53. A method as set forth in claim 52, wherein said step of connecting the overlapped lateral edge portions includes using a pair of rotating connecting members forming therebetween a nip through which the overlapped lateral edge portions of the layers pass.

54. A method as set forth in claim 53, wherein said rotating connecting members have a plurality of teeth interacting with the teeth on the other to stitch together the overlapped lateral edge portions.

55. A method as set forth in claim 52, including the step of supplying the plurality of the layers as a multi-ply stock material and then separating the layers before said shaping step.

56. A method as set forth in claim 55, wherein said shaping step includes passing said layers through a converging chute.

57. A method of converting plural layers of sheet-like stock material into a cushioning product, said method comprising the steps of:

shaping a first layer of the stock material into a casing with the lateral edge portions being brought into overlapping relationship one inside the other;

shaping at least a second layer of the stock material into a stuffing for the casing;

connecting, downstream of the first shaping step, the overlapped lateral edge portions of the first layer; and

feeding, downstream of the second shaping step, the second layer into the interior of the casing.

58. A method of converting plural layers of sheet-like stock material into a cushioning product, said method comprising:

shaping plural layers of the stock material into a three dimensional strip of dunnage having central portions and overlapped edge portions;

connecting, downstream of the forming step, overlapped lateral edge portions of the layers separately from central portions of said layers; and

guiding the central portions of the layers to prevent the central portions from being connected.

59. A cushioning product comprising plural layers of sheet-like material folded upon themselves, at least the outer layer of said plural layers having lateral edge portions overlapped and connected together separate from a central portion of said outer layer, said overlapped lateral edge portions of said outer layer being generally coplanar with adjacent unoverlapped portions of said outer layer.

60. A cushioning product as set forth in claim 59 wherein said plural layers of sheet-like stock material further comprise at least one inner layer having portions thereof folded upon themselves to produce a stuffing, and wherein the outer layer is formed into a tube surrounding said stuffing and wherein said overlapped edge portions of the tube are stitched together separate from said stuffing.

61. A cushioning product as set forth in claim 59 wherein said plural layers of sheet-like stock material further comprises at least one inner layer having lateral edge portions overlapped and stitched together separate from a central portion of said inner layer and wherein lateral edge portions of said inner layer overlap and are stitched together with said lateral edge portions of said outer layer.

62. A cushioning product as set forth in any of claims 59-61 wherein said plural layers of sheet-like stock material comprises more than one inner layer.

63. A cushioning product comprising plural layers of sheet-like stock material folded upon themselves, an outer layer of the plural layers having lateral edge portions

overlapped and connected together separate from a central portion of the other layer, the remaining inner layers also having lateral end portions overlapped and connected together separate from their respective central portions.

64. A cushioning product comprising plural layers of sheet-like stock material folded upon themselves, an outer layer of the plural layers having lateral edge portions overlapped and connected together separate from a central portion of the outer portion of the outer layer, the remaining inner layers of the plural layers also having lateral end portions overlapped and connected together with the overlapped lateral edge portions of the outer layer.

65. A machine, method, or product according to any of the preceding claims wherein said plural layers of stock material comprises biodegradable, recyclable and reusable Kraft paper.

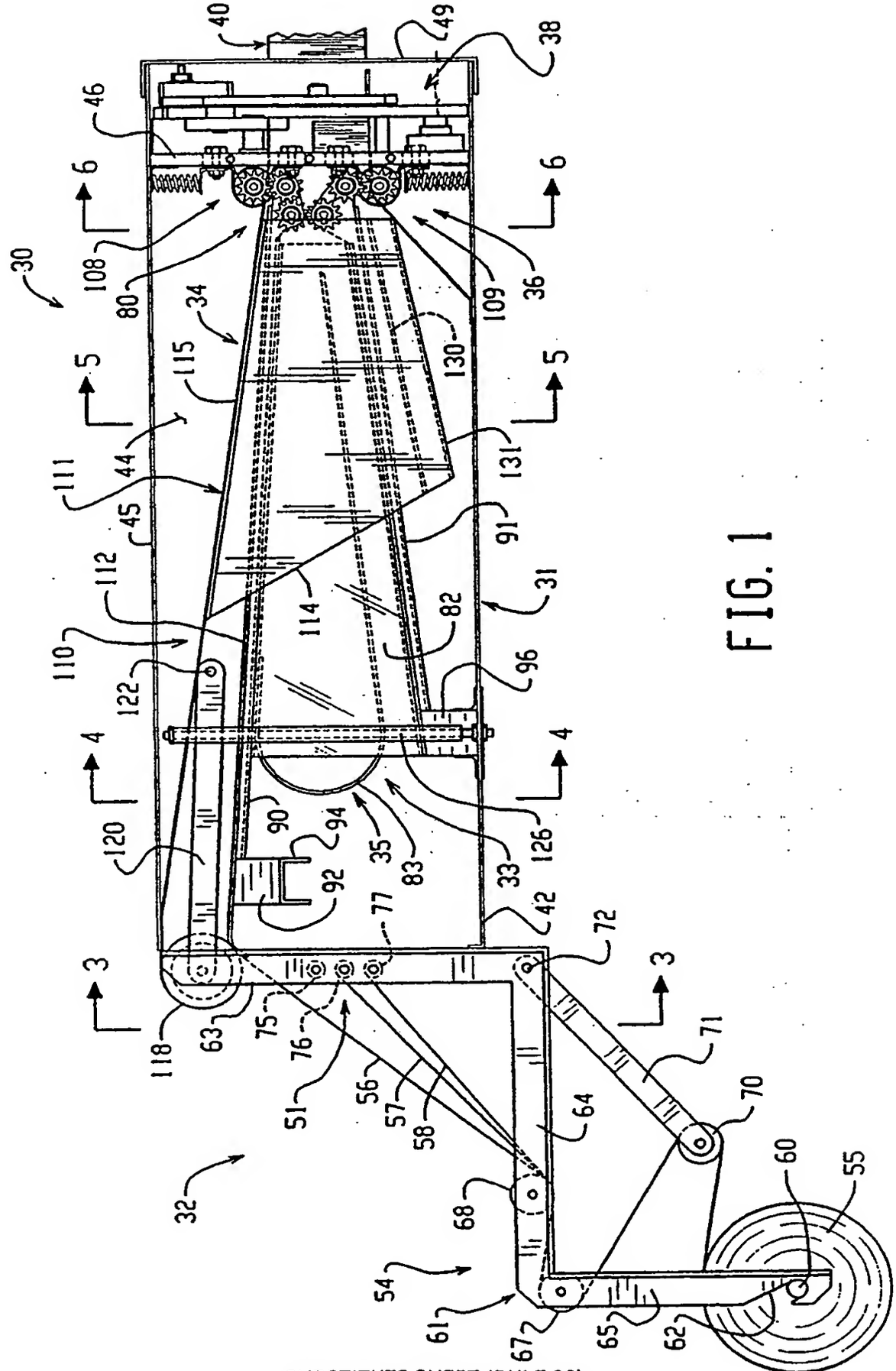
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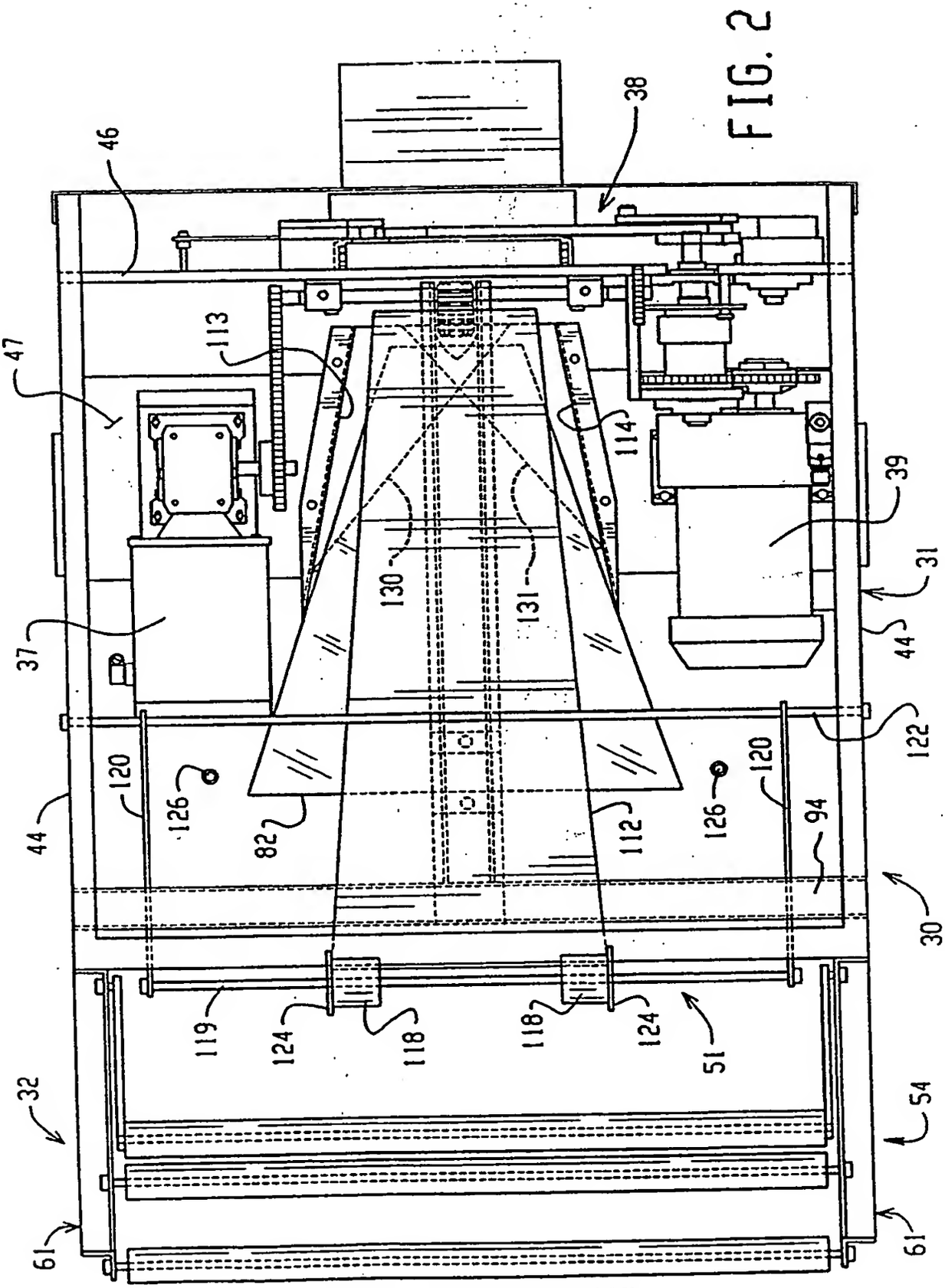
FIG. 1

FIG. 2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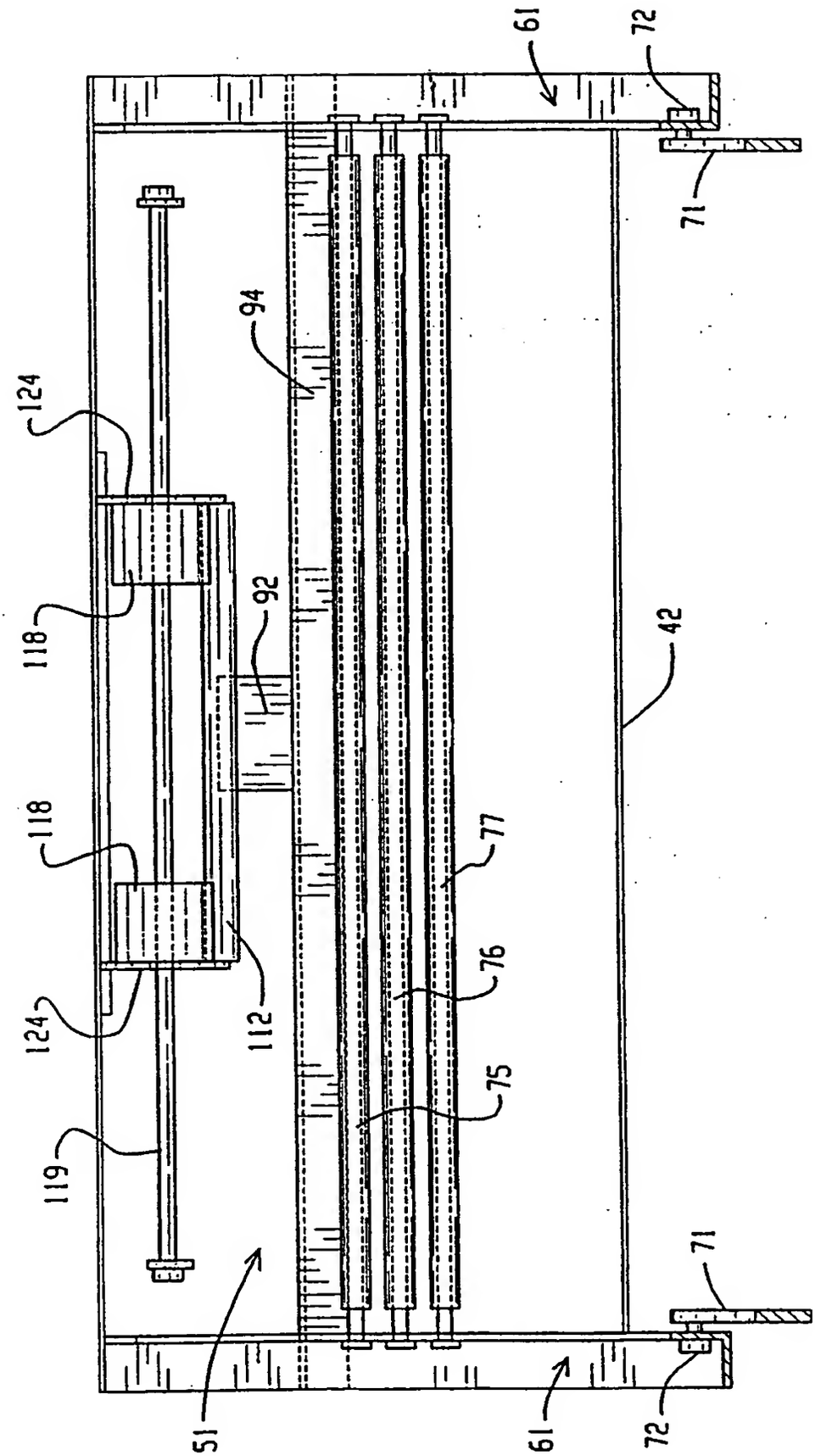
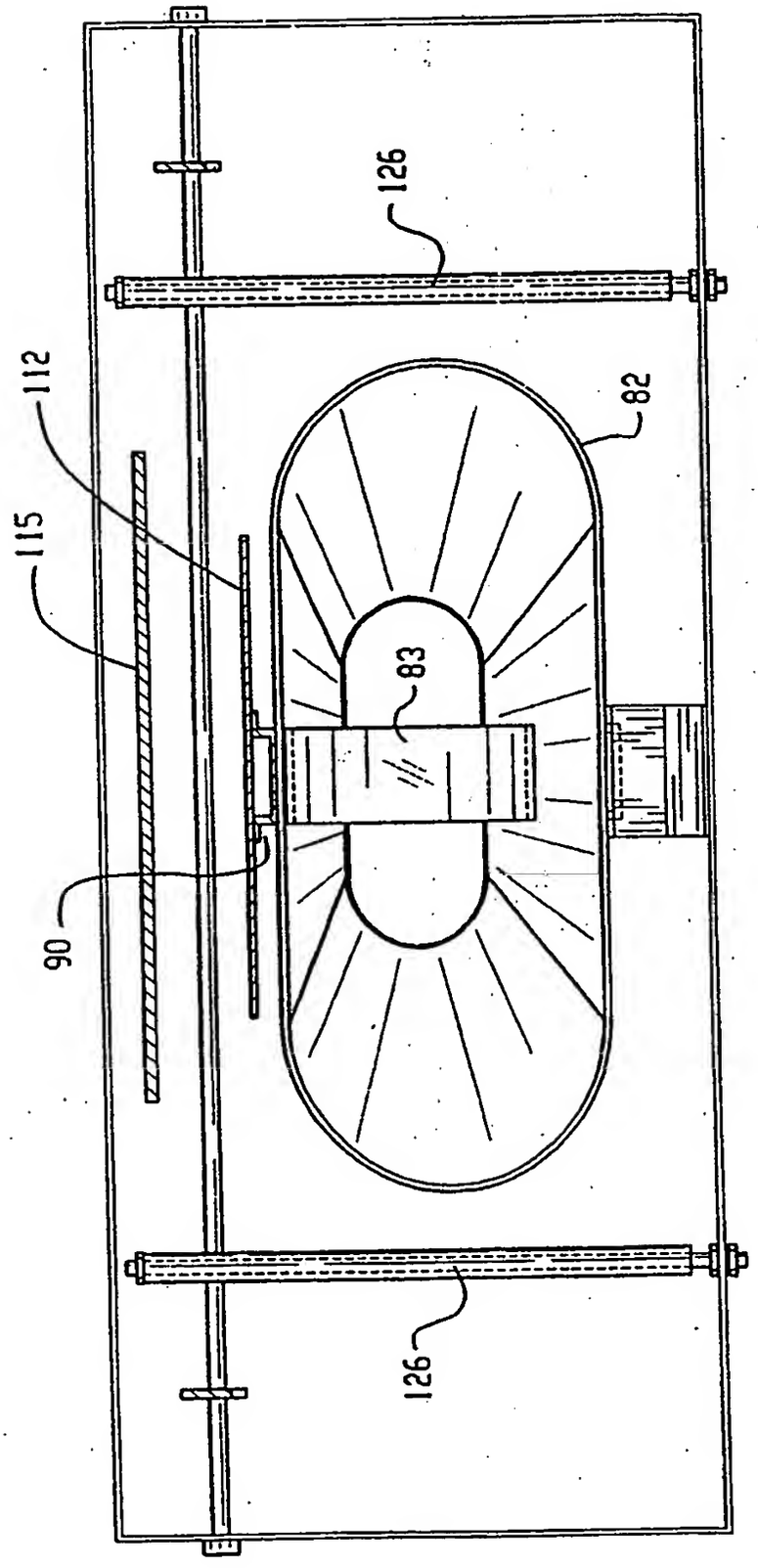


FIG. 3



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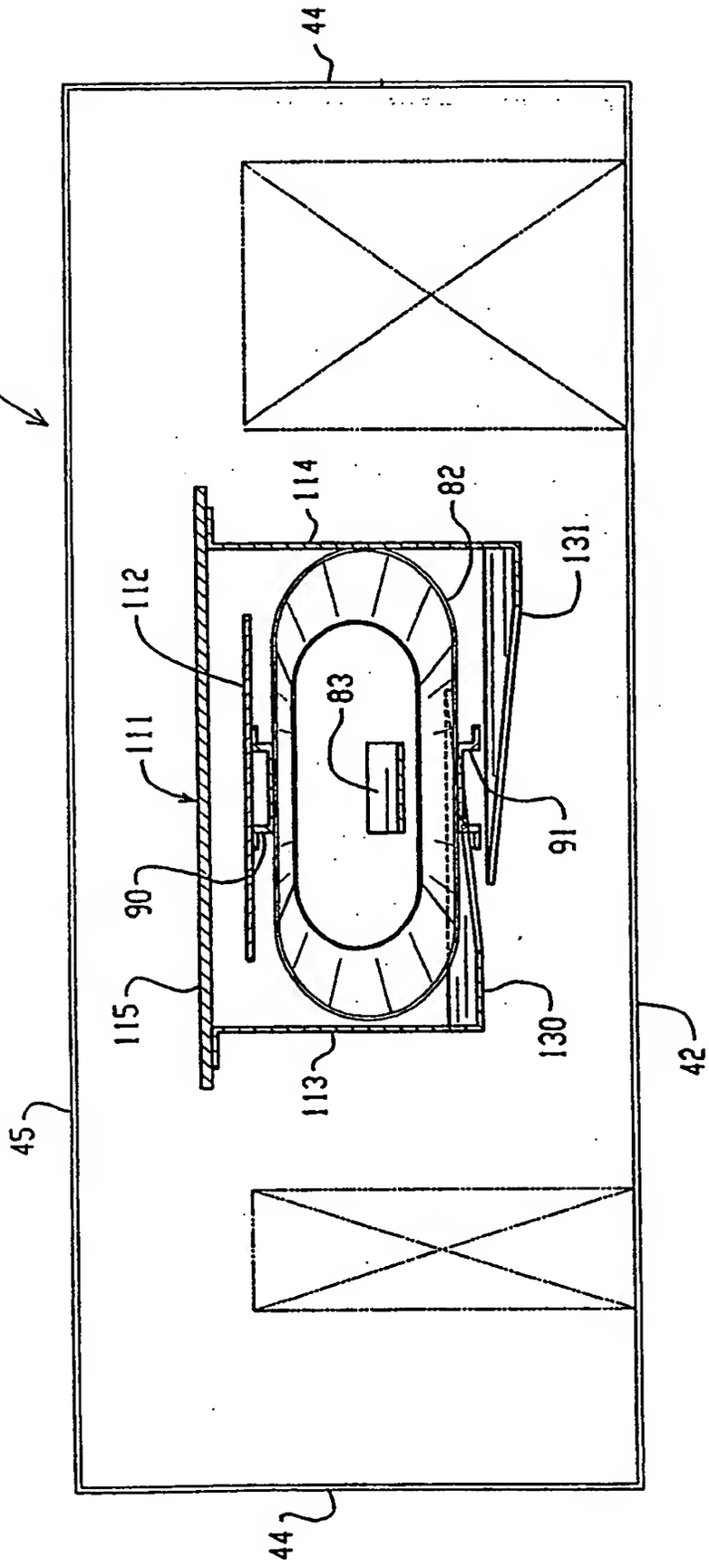

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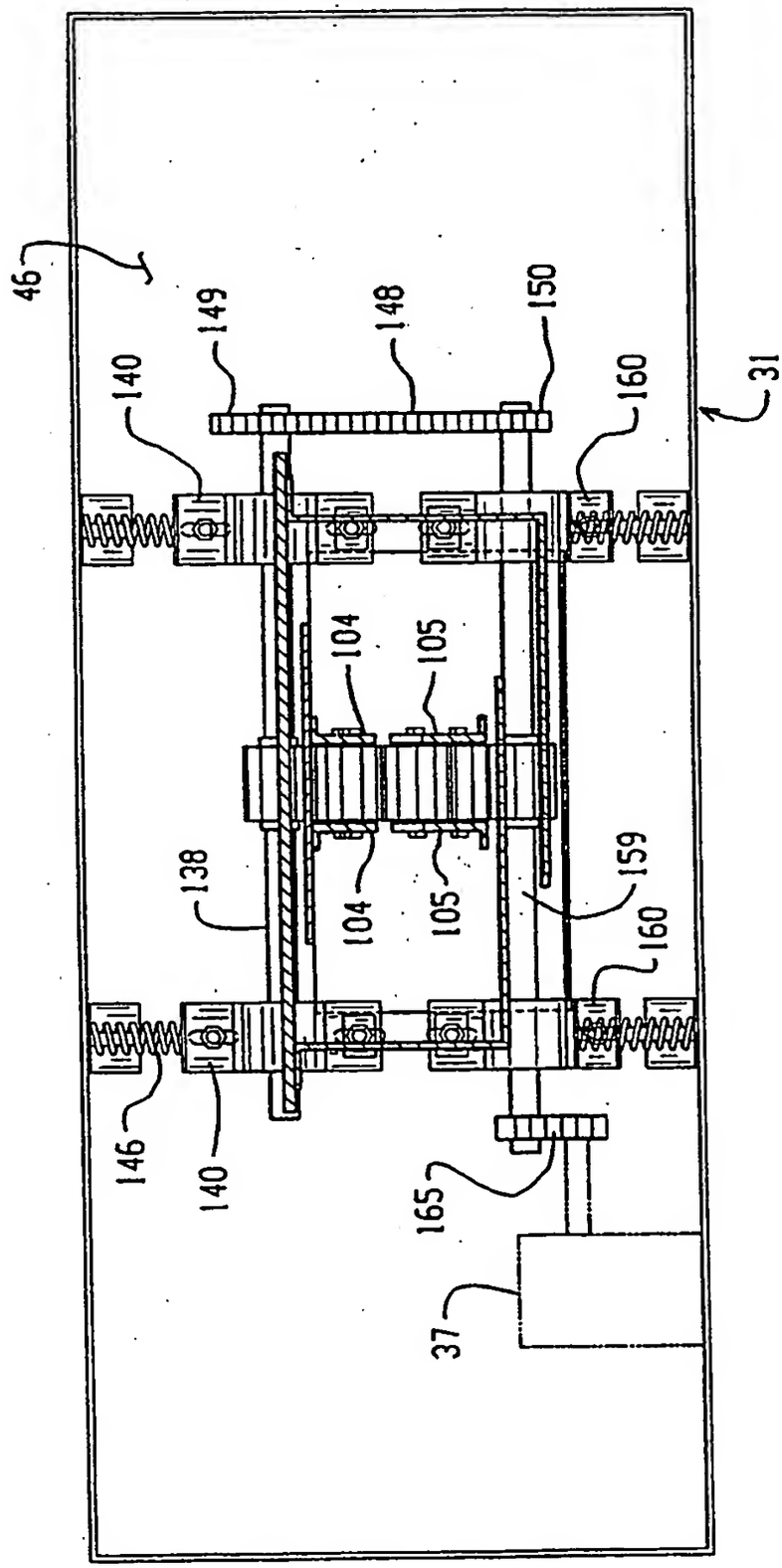

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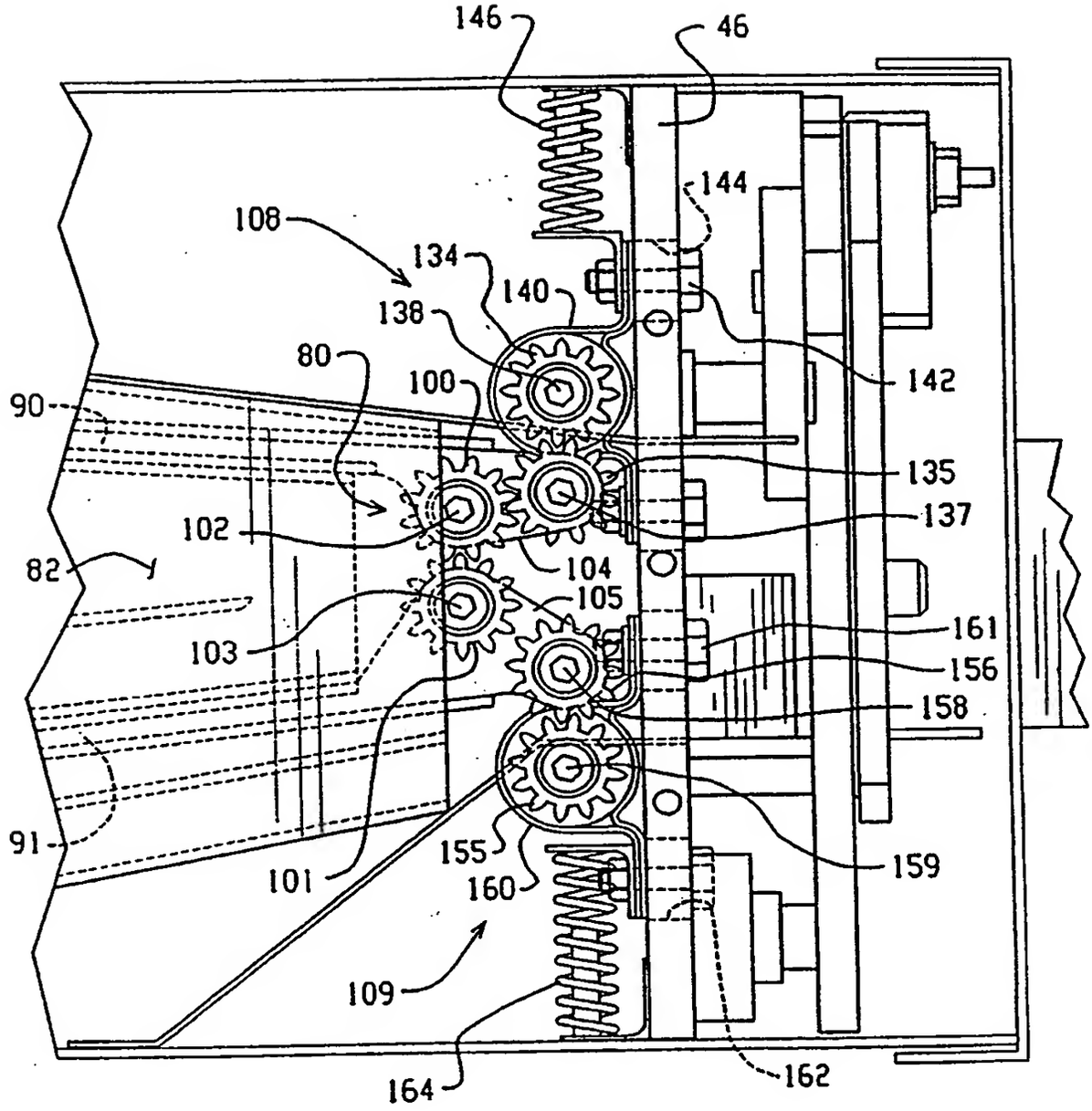
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FIG. 7

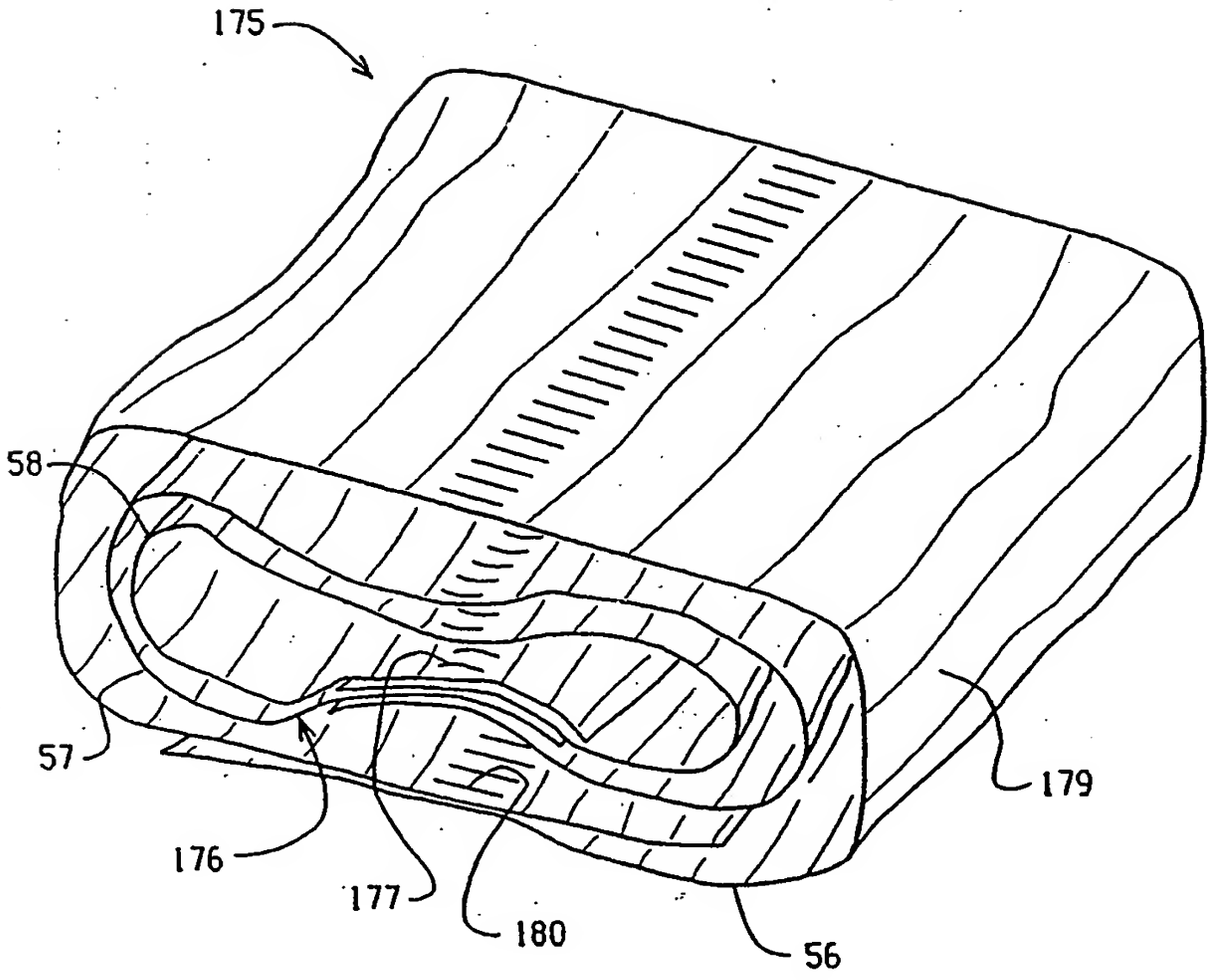

FIG. 8

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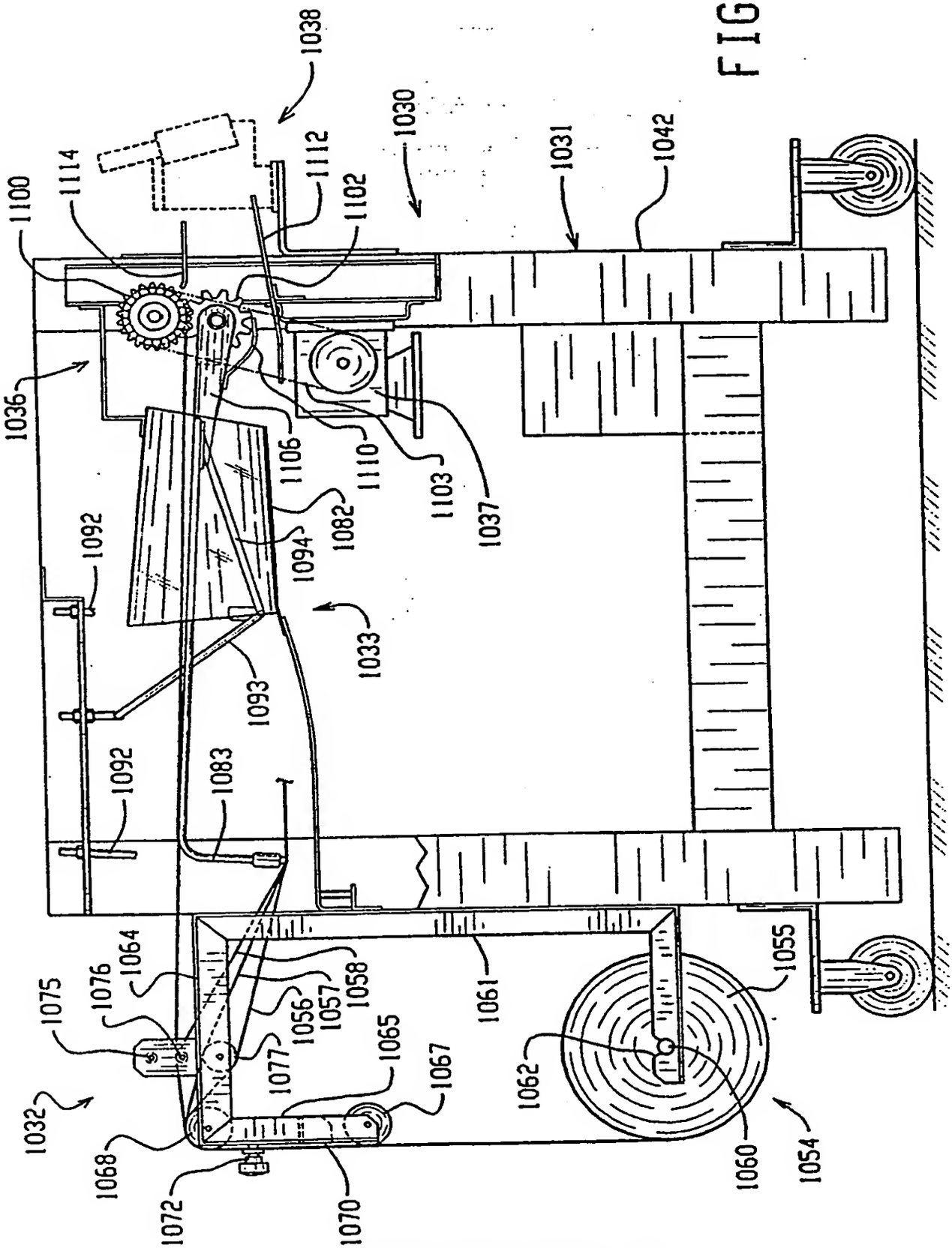
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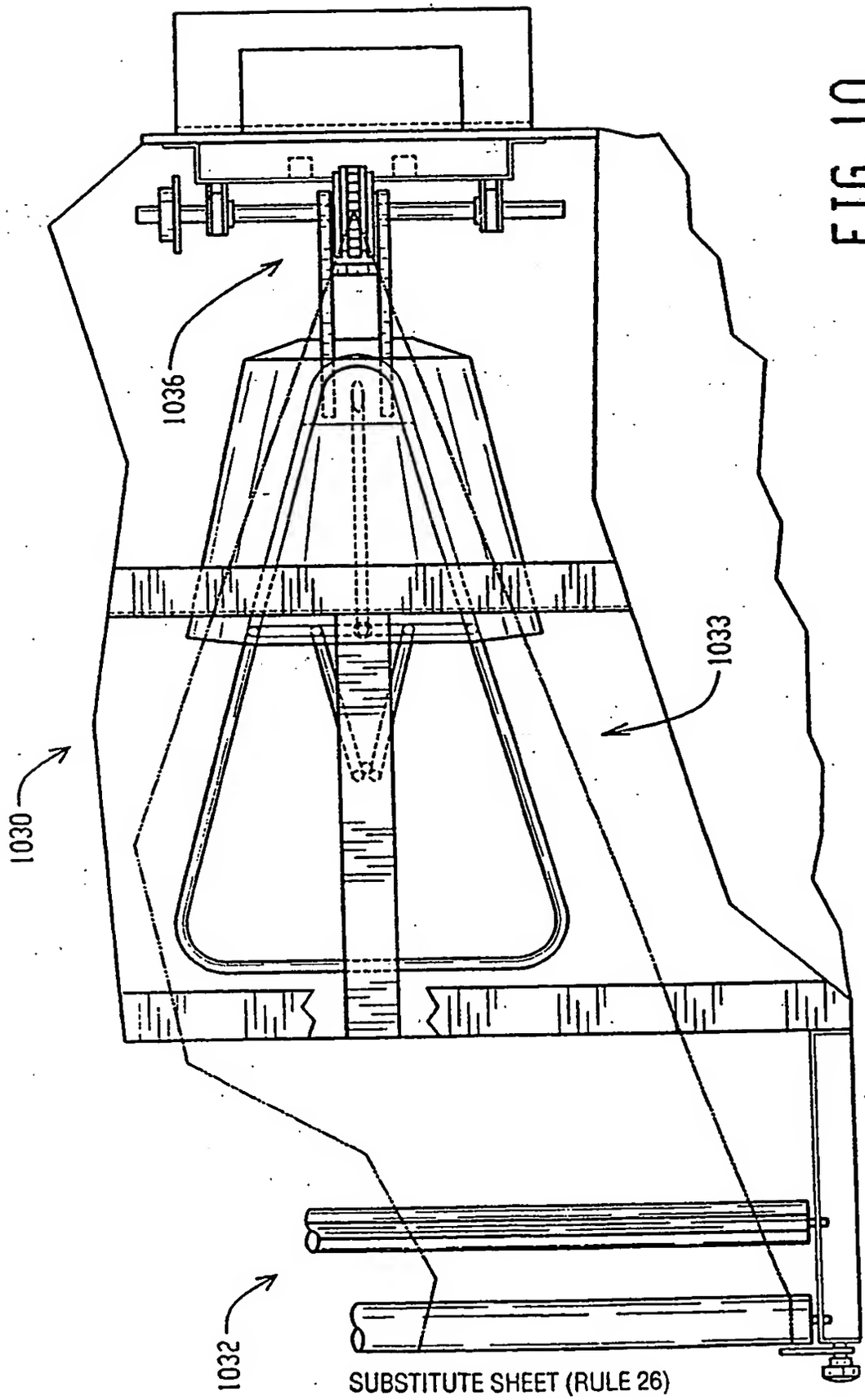
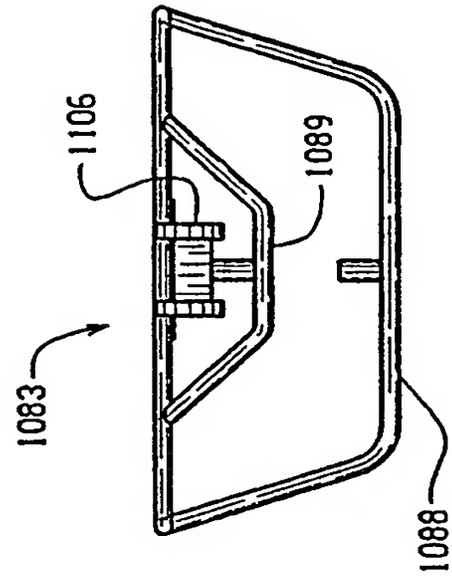


FIG. 10



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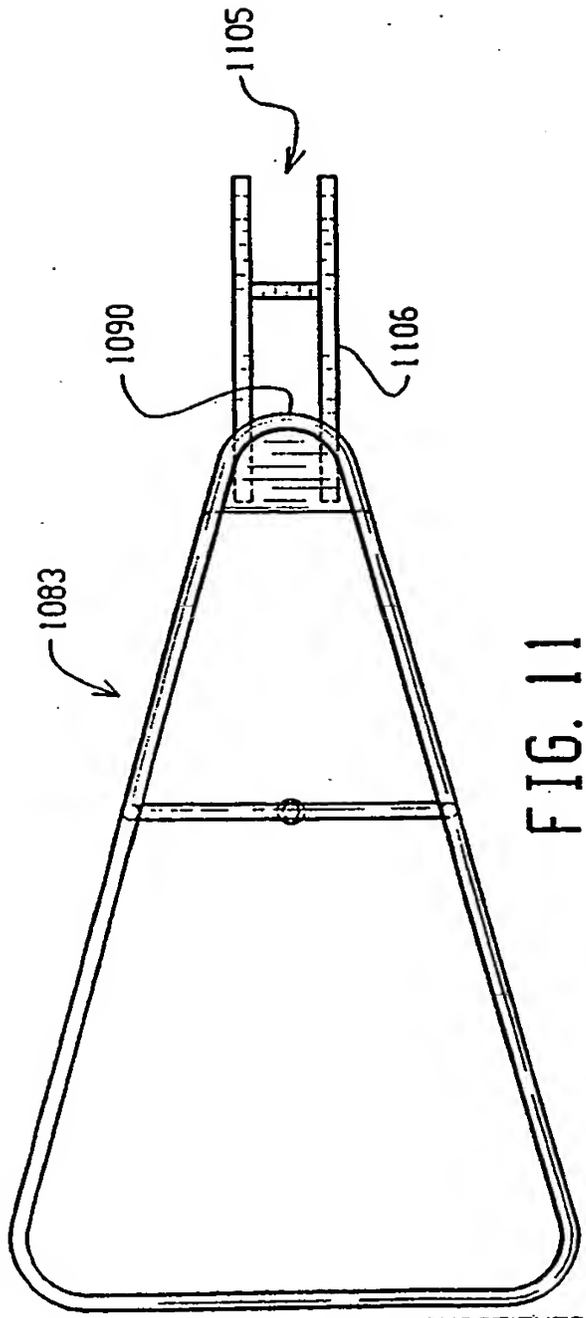
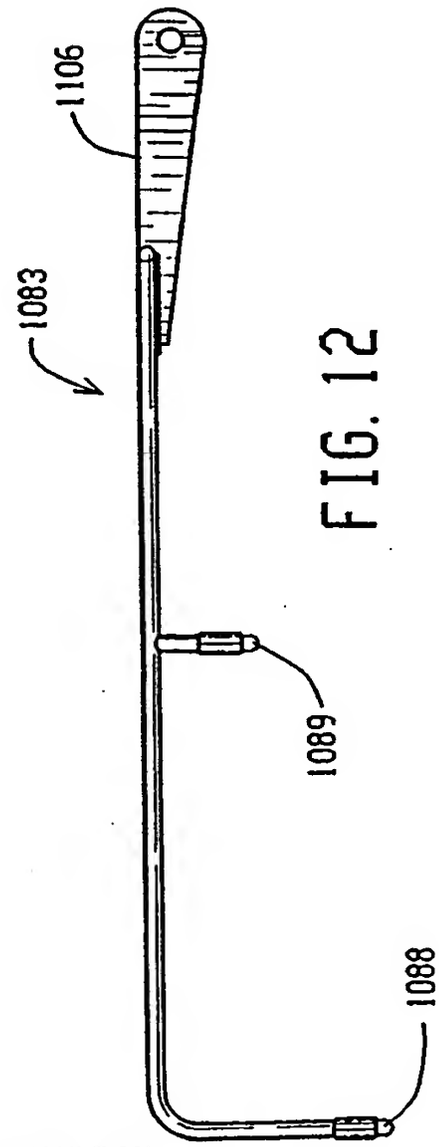


FIG. 11



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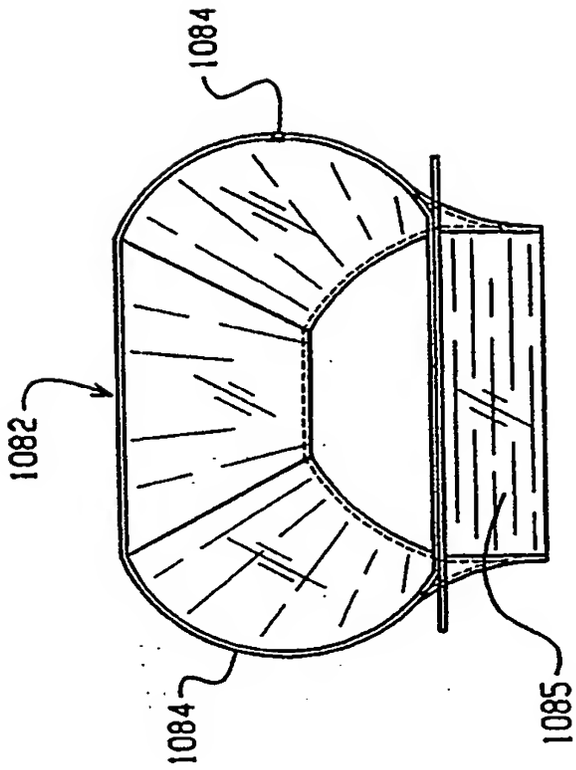

FIG. 16

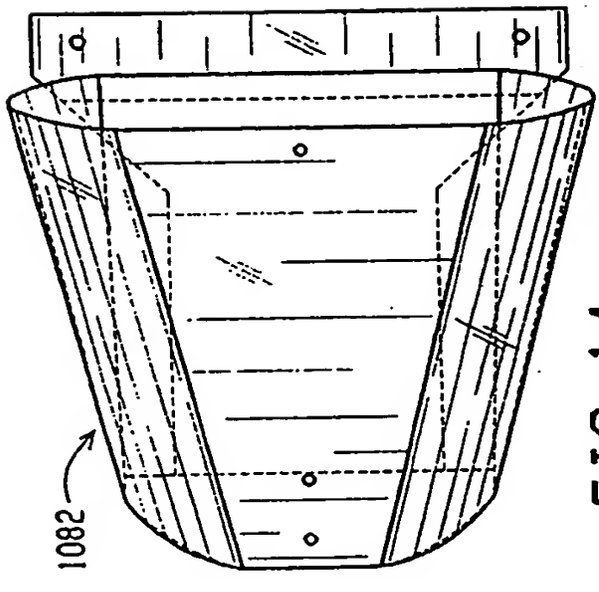

FIG. 14

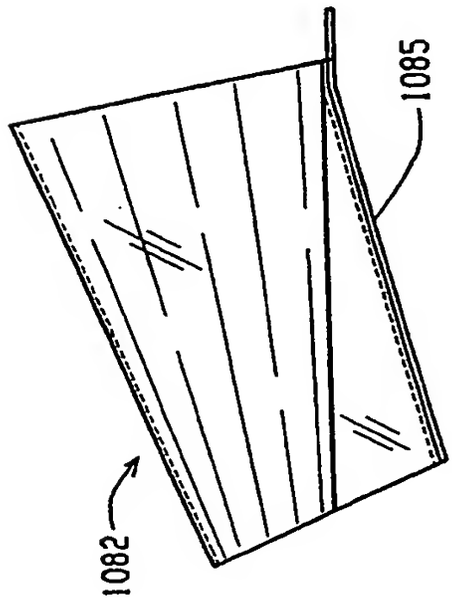

FIG. 15

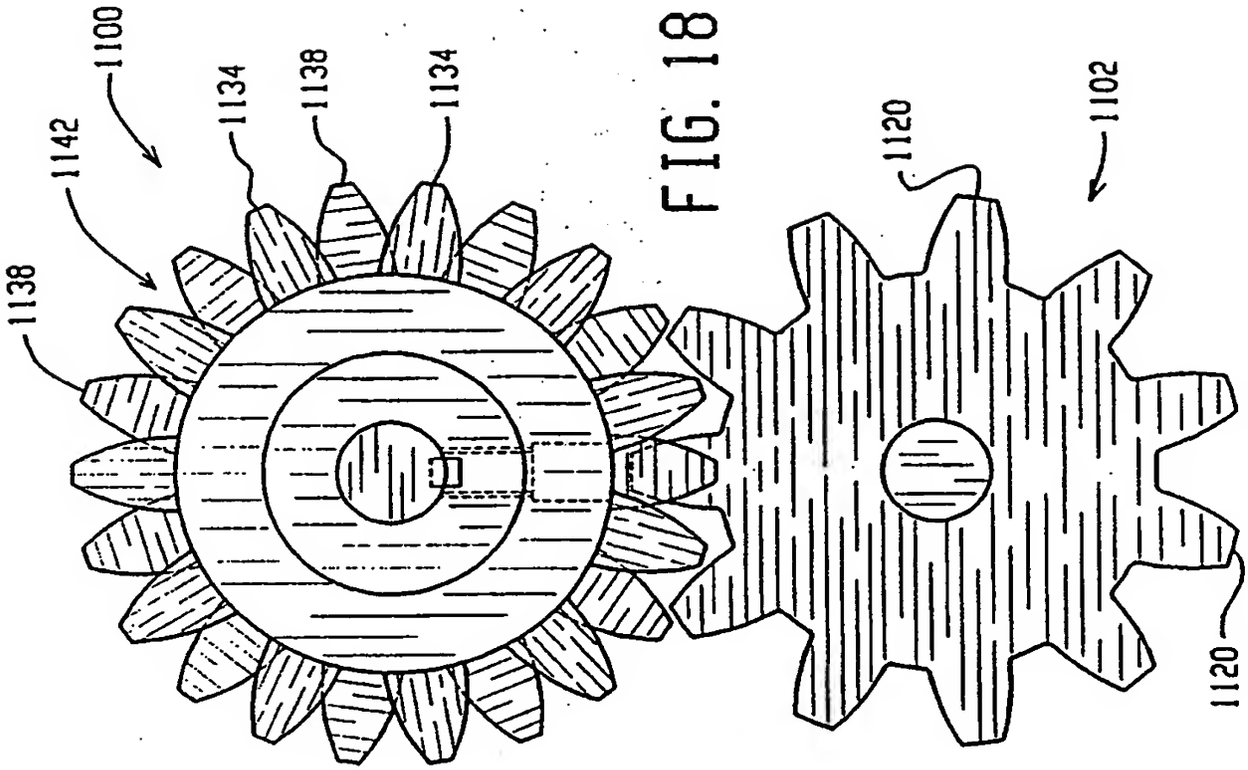
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FIG. 18

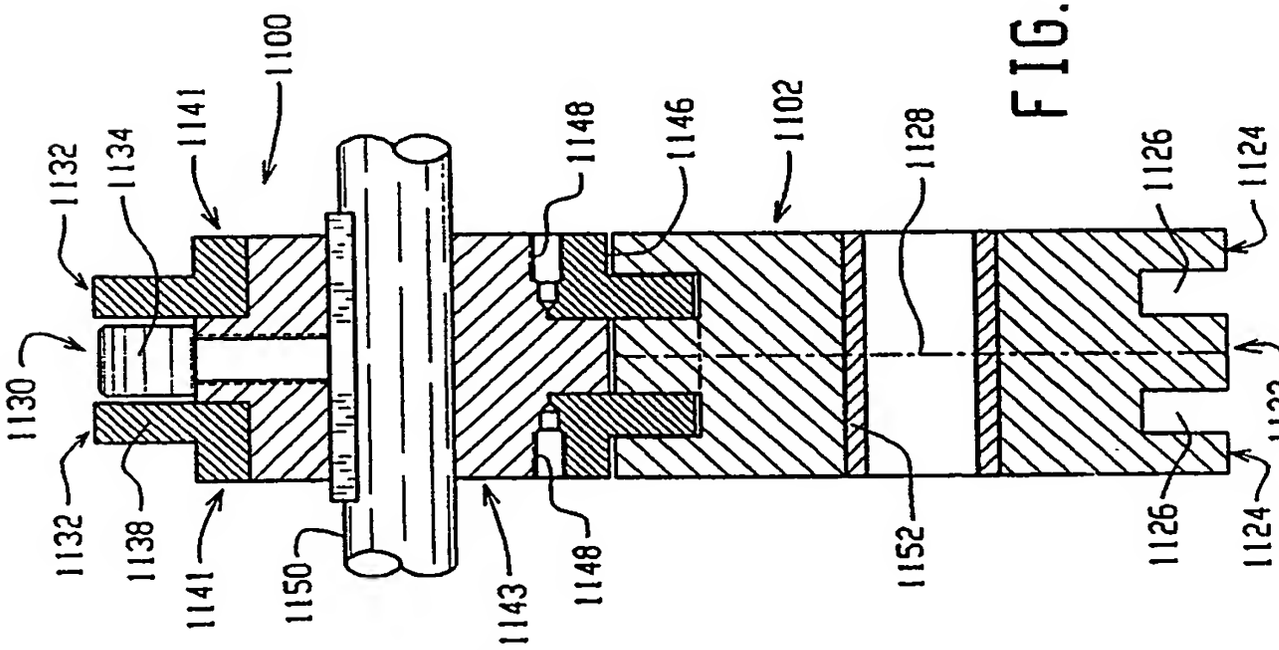
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FIG. 17

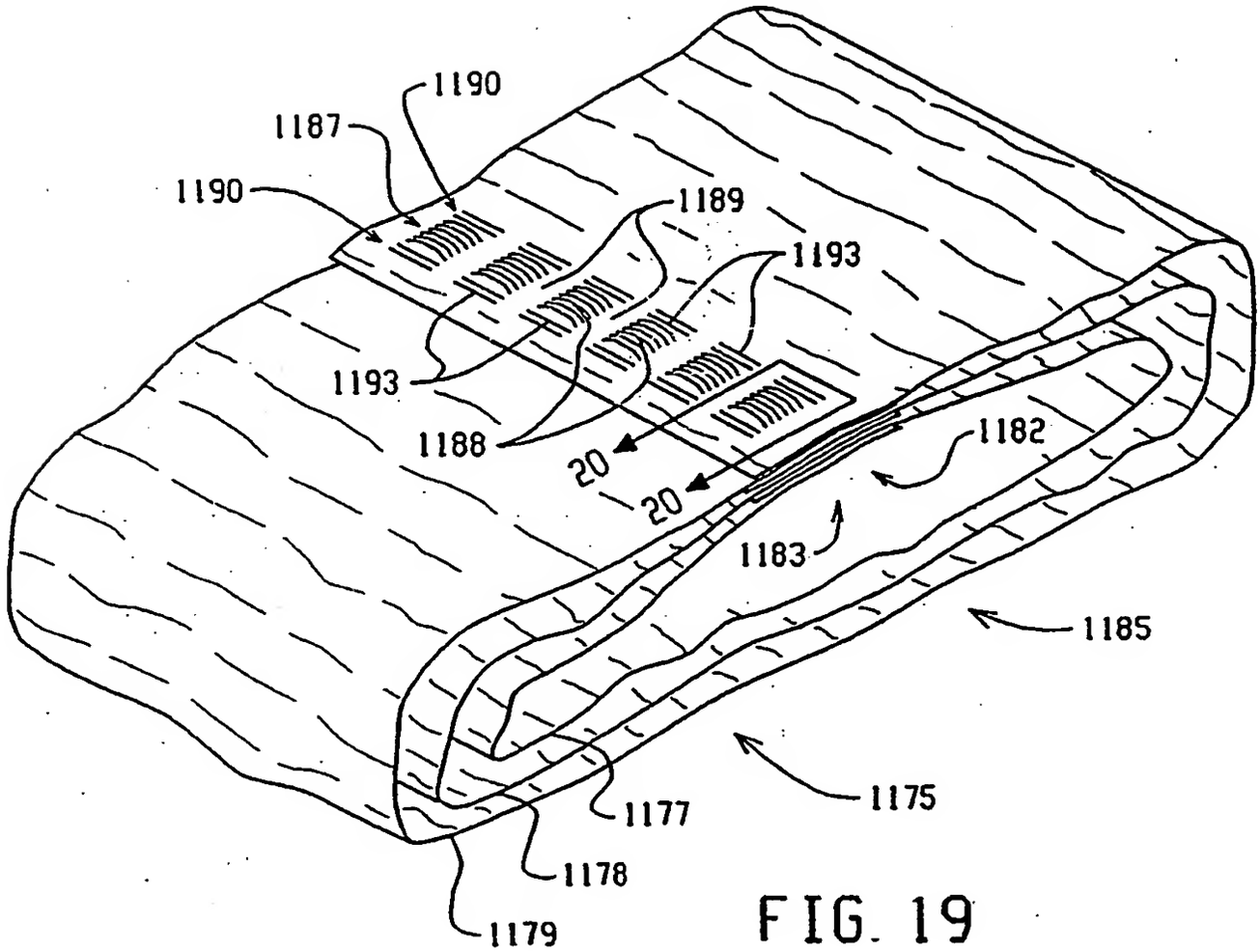
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FIG. 19

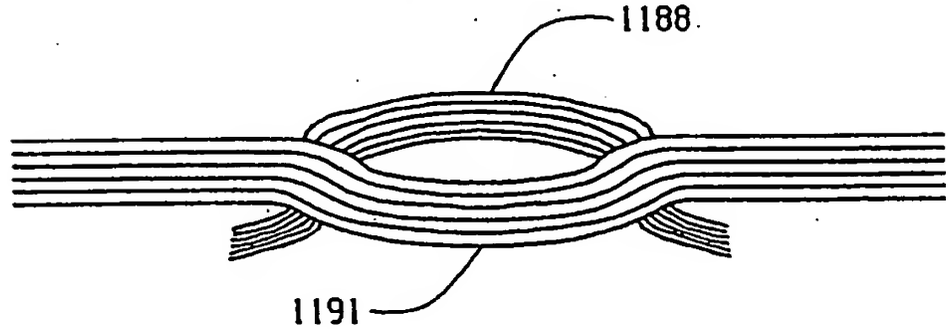
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FIG. 20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/09642

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B31F 1/10
US CL : 493/464
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 493/352,346,407,439,464,480,967

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ----- Y	US, A, 4,026,198 (OTTAVIANO) 31 MAY 1977, SEE ENTIRE DOCUMENT.	39,57 ----- 1-3,20,27, 28,30-34, 36-48, 52-56,58
X ----- Y	US, A, 4,237,776 (OTTAVIANO) 09 DECEMBER 1980, SEE ENTIRE DOCUMENT.	39,57 ----- 1-3,20,27, 28,30-34, 36,39-48, 52-56,58

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 30 AUGUST 1996	Date of mailing of the international search report 17 SEP 1996
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3579	Authorized officer for CHRISTOPHER W. DAY Telephone No. (703) 305-1148 Sheila Veney Paralegal Specialist Group 3200

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/09642

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US, A, 4,717,613 (OTTAVIANO) 05 JANUARY 1988, SEE ENTIRE DOCUMENT.	39,57 --- 1-3,20,27, 28,30-34, 36,39-48, 52-56,58
X --- Y	US, A, 4,750,896 (KOMARANSKY) 14 JUNE 1988,SEE ENTIRE DOCUMENT.	39,57 --- 1-3,20,27, 28,30-34, 36,39-48, 52-56,58
X --- Y	US, A, 4,937,131 (BALDACCI ET AL) 26 JUNE 1990, SEE ENTIRE DOCUMENT.	39,57 --- 1-3,20,27, 28,30-34, 36,39-48, 52-56,58
X --- Y	US, A, 5,061,543 (BALDACCI) 29 OCTOBER 1991, SEE ENTIRE DOCUMENT.	39,57 --- 1-3,20,27, 28,30-34, 36,39-48, 52-56,58
X --- Y	US, A, 4,884,999 (BALDACCI) 05 DECEMBER 1989, SEE ENTIRE DOCUMENT.	39,57 --- 1-3,20,27, 28,30-34, 36,39-48 52-56,58
X --- Y	US, A, 5,188,581 (BALDACCI) 23 FEBRUARY 1993, SEE ENTIRE DOCUMENT.	39,57 --- 1-3,20,27 28,30-34, 36,39-48, 52-56,58
X	US, A, 1,723,355 (ROWE) 06 AUGUST 1929, SEE ENTIRE DOCUMENT.	59-65

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/09642

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 2,663,072 (PFISTERSHAMMER) 22 DECEMBER 1953, SEE ENTIRE DOCUMENT.	59-65
Y	US, A, 2,935,002 (ROBINSON) 03 MAY 1960, SEE ENTIRE DOCUMENT.	59-65
Y	US, A, 5,471,783 (MCLEAN) 05 DECEMBER 1995, SEE ENTIRE DOCUMENT.	59-65